

# *Geospatial Workforce Development*

A compendium of white papers focused on  
advancing geospatial workforce development.



A Report of the  
National Geospatial Advisory Committee

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**Note – This paper was adopted by the NGAC on January 12, 2012**

## Preface

The United States is a world leader in geospatial technology and research, an area that represents a multi-billion sector of the US economy. This high growth, high technology industry acquires, manages, analyzes, integrates, maps, distributes, and uses geographic, temporal, and spatially based information and knowledge to fuel major sectors of the US economy. The industry includes research, technology development, education, and applications to address the planning, decision-making, and operational needs of people and organizations of all types.

This vital industry faces a serious workforce development challenge. A shortage of qualified and skilled workers exists to meet the demands of this fast growing industry. Efforts must be undertaken across all levels of government, private sector, academic community, and professional associations to prepare workers to take advantage of new geospatial job opportunities in high demand and economically vital sectors of the American economy.

Establishing an effective geospatial job market requires a direct connection between the employer's job requirements and the geospatial skills of the workforce. Determining the competencies that employers require in order to satisfy their business needs in the geospatial industry is critical. A competency-based approach for defining required skills becomes necessary in technology-based occupations such as the geospatial profession. Solving these workforce issues requires new methods, practices, partnerships, and outreach for this high growth, high technology industry among industry, academia, and government.

Advancing the Nation's geospatial workforce will result in a set of benefits where:

- Public awareness of geospatial technologies and their applications are raised, and better connections are built between the geospatial industry and diverse populations of potential workers;
- Public and private organizations can build partnerships with educational institutions at all levels to create effective and efficient geospatial training and education, and recruitment programs;
- Commercial, academic, nonprofit organizations, and all levels of government use a complementary set of geospatial competencies to support systematic geospatial learning and development of training and education programs and curricula;
- Effective and compelling public outreach programs and informational materials about the geospatial profession are distributed through geospatial professional organizations and existing DOL-supported education and information channels; and
- A set of skills standards describe the kinds of workers needed to support the geospatial industry; improve employee recruitment and selection; and advance geospatial technology.

These direct and indirect benefits ultimately work to better align educational, employment, and workforce development programs with employers' labor needs, ultimately providing public and private organizations with the knowledge and skills employees need to be successful.

The Subcommittee has developed this white paper to describe the challenges and advancements with geospatial workforce development and to set a context from which in part we will base our future discussions. While this paper is not meant to be all-inclusive with geospatial workforce development, we do believe it highlights the major elements and identifies a number of recommendations for moving forward. We encourage the reader to follow our deliberations and progress at [www.fgdc.gov/ngac](http://www.fgdc.gov/ngac). Special thanks go John Mahoney and Tricia Longo Gibbons for their direction and support in developing this document.

*Dave DiSera*

*Chair, NGAC Geospatial Workforce Development Subcommittee*

## **The Administration's STEM Education Initiatives from a Geospatial Workforce Development Perspective**

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### **Background/Overview**

The goals of this paper are to examine opportunities for synergies with the Administration's Science, Technology, Engineering, and Mathematics (STEM) education initiatives, assess opportunities to incorporate Geospatial and Geomatics education into the four STEM categories, and assess potential role/involvement/support from FGDC and NGAC.

As a job sector, the geospatial technology field is exploding. Jobs are being created faster than we can find the minds we need to fill them. The Department of Labor recently identified geospatial technology as one of fourteen sectors "projected to add substantial numbers of new jobs to the economy or affect the growth of other industries or are being transformed by technology and innovation requiring new sets of skills for workers." Furthermore, geospatial technology requires cutting edge scientific and engineering analyses, utilizes high-end computing technology, and involves fundamental understanding of mathematical principles. Despite this amazing industry growth and innovation, and congruence with all aspects of STEM, few educational programs integrate geography and geospatial education within the STEM curriculum.

The Workforce Development Subcommittee believes that inclusion of geospatial disciplines in the White House STEM initiatives would increase the probability that the initiatives will be successful and increase the degree of their success. To that end, the Subcommittee believes NGAC should engage those decision makers entrusted with implementing the Administration's vision, e.g., the White House Committee on Science, Technology, Engineering, and Math education (CoSTEM) and the National Science Foundation (NSF), to illuminate the importance and benefits of developing a highly skilled geospatial workforce through STEM education.

### **Emerging Trends and Best Practices**

#### **The Administration's Support for STEM**

Science, Technology, Engineering, and Mathematics (STEM) education is a national imperative. In the 21st century, technology is a fundamental driver of economic growth and prosperity, especially in the U.S. Studies show that technological innovation accounted for almost half of U.S. economic growth over the past 50 years. Almost all of the 30 fastest-growing occupations in the next decade will require a background in STEM.<sup>i</sup>

President Obama identified STEM education as a "national priority" and established the "Educate to Innovate" campaign in 2009 to mentor the next generation of technological leaders. Congress also strongly supports STEM, as evidenced by the passage of "America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Reauthorization Act" or "America COMPETES" in 2010. This act called for the creation of the Committee on Science, Technology, Engineering, and Math Education (CoSTEM) within the White House's National Science and Technology Council (NSTC). Launched in March 2011, CoSTEM seeks to develop the strategic groundwork for effective STEM education investments. CoSTEM's focus is to create an inventory of federal STEM education activities and to develop a five-year strategic federal STEM education plan.<sup>ii</sup>

Today, the Federal Government has a handful of programs directly related to geospatial or remote sensing. For example, the National Science Foundation's (NSF) Geography and Spatial Sciences (GSS) Program seeks to

advance discovery, basic understanding, and education in geography and the spatial sciences.<sup>iii</sup> In addition, the National Oceanic and Atmospheric Administration's (NOAA) Cooperative Remote Sensing Science and Technology (CREST) Center encourages research on all aspects of remote sensing including sensor development, satellite remote sensing, ground-based field measurements, data processing and analysis, modeling, and forecasting.<sup>iv</sup> However, the fact that only a couple of Federal agencies have created STEM programs to directly promote the geospatial and remote sensing fields indicate there are challenges in Federal STEM education prioritization and implementation.

## Opportunities and Challenges

### Challenges to Government-wide STEM Education

For fiscal year 2012, the President's total budget request was \$3.4 billion for STEM programs across all federal agencies.<sup>v</sup> Despite this robust political support for STEM education, planning for STEM education is inconsistent. No single definition exists delineating which subject areas STEM education incorporates. The closest Administration-approved description of STEM is from a September 2010 President's Council of Advisors on Science and Technology report stating:

"STEM education," as used in this report, includes the subjects of mathematics, biology, chemistry, and physics, which have traditionally formed the core requirements of many state curricula at the K-12 level. In addition, the report includes other critical subjects, such as computer science, engineering, environmental science, and geology, with whose fundamental concepts K-12 students should be familiar. The report does not include the social and behavioral sciences, such as economics, anthropology, and sociology; while appropriately considered STEM fields at the undergraduate and graduate levels, they involve very different issues at the K-12 level.<sup>vi</sup>

The definition's ambiguity hampers everyone's ability to determine what programs fall under a STEM curriculum. Members of the Coalition of Geospatial Organizations (COGO) expressed concern, in a letter to the Director of the Office of Science and Technology Policy, that this report defines STEM fields far too narrowly, thus excluding core social science disciplines such as geography.

In a 2005 report on Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends, the GAO attempted to classify STEM programs into nine STEM fields for students, eight STEM fields for graduates, and the four broad STEM fields for occupations.<sup>vii</sup> This list of classifications differs from other federal lists, such as the Department of Homeland Security's STEM-Designated Degree Program List, which endeavors to list every possible collegiate degree related to STEM.<sup>viii</sup> With the recent creation of CoSTEM, the members of this committee will begin the challenging process of creating a cohesive strategy to classify STEM education in order to introduce clarity, prevent redundancies, and improve program effectiveness.

With almost every federal agency hosting several STEM-related programs, there are many niche projects across the government that might be used to advance STEM in a coordinated fashion but are not. The same 2005 GAO report found that in the 13 federal civilian agencies surveyed, the Federal Government spent over \$2.8 billion on STEM for 209 different programs. It further reported that coordination among these programs was limited.<sup>ix</sup> STEM education programs focus on topics ranging from long division for kindergarteners to molecular biology for doctoral candidates.

In measuring the effectiveness of any initiative, the outputs of the programs must be examined in order to evaluate successes and areas for improvement. Many of the STEM programs do not undergo rigorous analysis to understand what inspires students to enter STEM degrees and occupations. Initial findings from university officials and researchers indicate that quality of teachers in kindergarten through 12th grades and the levels of mathematics and science courses completed during high school ultimately influence decisions to pursue STEM degrees.<sup>x</sup>

The Associate Executive Director of the STEM Coalition, an alliance working aggressively to raise awareness and foster policies to support STEM education, confirmed in an interview that there is no central location where STEM programs are administered within the Federal Government. Programs are scattered among many federal (and state) agencies. Therefore, different agencies may interpret the list of STEM degree programs to suit their agencies' unique needs. While most agencies with active programs maintain their own lists and requirements, it is often difficult to ascertain where they are located organizationally.

Currently, the Coalition is observing the work of the White House CoSTEM and expects the Inventory of Federal STEM Programs being conducted by a working group of the CoSTEM to be available in the next few months. There is also a CoSTEM Working Group to explore federal coordination of STEM programs. It is anticipated that once both reports are completed, programs will be evaluated as to results and impact.

It was also noted in the interview that the GAO was in the process of updating its 2005 Report: Higher Education Federal STEM Programs and Related Trends. The 2005 Report included data on over 200 Federal STEM programs as well as data on students and graduates in STEM fields.

### **Challenges with Geography/Geospatial Education**

The geospatial field is accelerating rapidly; however, geographical education lacks proper funding. The No Child Left Behind Act of 2001 (Elementary and Secondary Education Act) recognizes geography as a "core academic subject," but it remains the only core subject that never received any funding authorizations or appropriations.<sup>xi,xii</sup> Therefore, it is not surprising that in 2010, the National Assessment of Educational Progress rated only 21% of 12th graders proficient or better in geography education.<sup>xiii</sup>

Students are not the only group that needs geospatial education or improvement. A National Geographic survey of educators found that 7 of 10 believed their professional development opportunities in geography were inadequate.<sup>xiv</sup> Without proper funding for geography at elementary and secondary levels, both students and teachers are unaware of the various career opportunities in the geospatial industry. The U.S. News and World Report is a well-known source on university ranking that many students use when evaluating schools and programs. The Report does not list geography or geospatial sciences when rating degrees for Masters' programs, further exemplifying the public's lack of awareness on the subject of geospatial sciences.<sup>xv</sup>

While the aforementioned NSF and NOAA programs benefit the advancement of geospatial technology, these programs are also underfunded. Only 12-15% of applicants receive grants through the NSF's GSS Program due to the sheer volume of qualified applicants.<sup>xvi</sup> The CREST Center is funded through a single five-year grant from NOAA's Office of Education' Educational Partnership Program, which expired in September 2011.<sup>xvii</sup> Without federal support for geography and geospatial technology education for both students and teachers, serious shortfalls will exist in the geospatial workforce in the coming years.

### **Emerging Opportunities**

There are not-for-profit organizations that support STEM education inclusive of geography and geospatial curricula, tools, materials, and technology. TERC, an education research organization with a broad definition of STEM, offers professional development training, curricula, and materials in support of geography and geospatial technology as well as other STEM disciplines.

Recently, The National Science Foundation awarded a 2.2 million dollar grant to National Geographic, the National Council for Geographic Education (NCGE), the Association of American Geographers (AAG), and the American Geographical Society to collaboratively develop a "Roadmap to Implement 21<sup>st</sup> Century Geographic Education." The project will bring together industry experts, educators, and researchers to focus on improving geography education including instructional materials, teacher professional development, research, and assessment.

## Active Organizations and Their Focus

**The President's Council of Advisors on Science and Technology (PCAST)** is an advisory group of the nation's leading scientists and engineers who directly advise the President and the Executive Office of the President. PCAST makes policy recommendations in the many areas where understanding of science, technology, and innovation is key to strengthening our economy and forming policy that works for the American people. PCAST is administered by the Office of Science and Technology Policy (OSTP). In September 2010, PCAST released a plan for improvements in K-12 STEM Education.

<http://www.whitehouse.gov/administration/eop/ostp/pcast>

**TERC** is a not-for-profit education research and development organization dedicated to improving mathematics, science, and technology teaching and learning. Founded in 1965, TERC works at the frontiers of theory and practice to enhance instruction through teacher professional development, develop applications of new technologies to education, create curricula and other products, and support reform in both school and informal settings. STEM education and professional development for teachers is a core mission area. Geography and geospatial topics are included as part of their professional development, curricula, and materials.

<http://www.terc.edu/>

The **STEM Coalition** represents the broadest voice in advocating for policies to improve STEM education at all levels. The alliance of more than 500 business, professional, and education organizations works aggressively to raise awareness in Congress, the Administration, and other organizations about the critical role that STEM education plays in enabling the U.S. to remain the economic and technological leader of the global marketplace. The Coalition supports an inclusive definition of the term "STEM" education by federal programs that is not limited to math and science, but embraces each STEM discipline and its unique needs.

[www.stemedcoalition.org](http://www.stemedcoalition.org)

**The National Council for Geographic Education** is a non-profit organization, chartered in 1915 to enhance the status and quality of geography teaching and learning. NCGE supports geography teaching at all levels from kindergarten through university. Activities include conducting and gathering research, producing journals and other geography publications, developing curricular resources at the K-12 and university levels, providing professional development opportunities, and organizing an annual conference.

<http://www.ncge.org/>

## Recommendations

The NGAC recommends that FGDC engage the Federal Government to include geospatial and geomatics studies in STEM programs through the following actions:

- 1.1 The FGDC leadership should work with and encourage CoSTEM to include geospatial technology and geomatics as components of the STEM disciplines.
- 1.2 The FGDC Secretariat and agency members should review and comment on the results of the CoSTEM Inventory of Federal STEM Programs and the CoSTEM Report on Federal Coordination.
- 1.3 The FGDC leadership should encourage awareness among FGDC member agencies regarding the importance of opportunities for geospatial technology related grants, such as the NSF's Geography and Spatial Sciences Program and NOAA's Cooperative Remote Sensing Science and Technology Center. Consider inviting NSF and NOAA to brief FGDC on how this model may be applied at other departments and agencies.
- 1.4 The FGDC leadership should encourage FGDC member agencies to establish internship, fellowship programs, cooperative education, or exchange programs that give students practical understanding and real-world experience with geospatial technology and applications.

- 1.5 The FGDC leadership should encourage FGDC member agencies to support geographic literacy through their respective education and outreach programs.

### Resources Reviewed and Related Links

- <sup>i</sup> “Why STEM?” *Change the Equation*. 2011. <<http://www.changetheequation.org/why/why-stem/>>.
- <sup>ii</sup> “NSTC Committee on Science, Technology, Engineering, and Math Education.” OSTP. 2011. <<http://www.whitehouse.gov/administration/eop/ostp/nstc/committees/costem>>.
- <sup>iii</sup> “Geography and Spatial Sciences (GSS).” National Science Foundation. 2011. <[http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=5410](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5410)>.
- <sup>iv</sup> “CREST Research Overview.” NOAA-CREST. 2010. <<http://crest.cny.cuny.edu/research/>>.
- <sup>v</sup> “Improving Science, Technology, Engineering, and Mathematics (STEM) Education. U.S. Department of Education. 14 February 2011. <<http://www2.ed.gov/about/overview/budget/budget12/crosscuttingissues/stemed.pdf>>.
- <sup>vi</sup> “Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future.” President’s Council of Advisors on Science and Technology. September 2010. <<http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf>>.
- <sup>vii</sup> “Higher Education: Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends.” Government Accountability Office. October 2005. <<http://www.gao.gov/new.items/d06114.pdf>>.
- <sup>viii</sup> “STEM-Designated Degree Program List.” Department of Homeland Security. 2008. <<http://www.ice.gov/sevis/stemlist.htm>>.
- <sup>ix</sup> “Higher Education: Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends.” Government Accountability Office. October 2005. <<http://www.gao.gov/new.items/d06114.pdf>>.
- <sup>x</sup> IBID p. 32-35.
- <sup>xi</sup> “No Child Left Behind Act of 2001.” Definitions: “Core Academic Subject.” 115 STAT. 1958. <<http://www2.ed.gov/policy/elsec/leg/esea02/107-110.pdf>>.
- <sup>xii</sup> “No Core Subject But Geography Left Behind: Program Funding Levels for Core Subjects under NCLB – FY 2002-2007.” National Geographic. <<http://www.nationalgeographic.com/foundation/pdf/NCLBAcademicAppropriations.pdf>>.
- <sup>xiii</sup> “Geography 2010: National Assessment of Education Progress at Grades 4, 8, and 12.” National Center for Education Statistics. U.S. Department of Education. July 2011. <<http://nces.ed.gov/nationsreportcard/pdf/main2010/2011467.pdf>>.
- <sup>xiv</sup> “Teaching Geography is Fundamental Act.” H.R. 885. Rep. Chris Van Hollen. 112th Cong., 1st Sess. (2011); “Teaching Geography is Fundamental Act.” S.434. Sen. Thad Cochran. 112th Cong., 1st Sess. (2011)
- <sup>xv</sup> “Education: Grad Schools.” *U.S. News and World Report*. <<http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools>>.
- <sup>xvi</sup> Phone discussion with a director for the GSS Program.
- <sup>xvii</sup> “NOAA-CREST Center Based At CCNY Receives Five-Year, \$12.5 Million Funding Commitment.” The City College of New York. <<http://www1.cny.cuny.edu/prospective/gsoe/news/noaa-funding.cfm>>.
- <sup>xviii</sup> Jodi Peterson, Associate Director of STEM Coalition, Interview with Tricia Gibbons indicated that the GAO will be releasing an updated report in late 2011 or early 2012.
- <sup>xix</sup> “President Obama Announces Goal of Recruiting 10,000 STEM Teachers Over the Next Two Years.” White House. 27 September 2010. <http://www.whitehouse.gov/the-press-office/2010/09/27/president-obama-announces-goal-recruiting-10000-stem-teachers-over-next->  
Discussions with representative and trainer from TERC  
Press Release: National Science Foundation Funds Experts To Develop Road Map To Implement 21st Century Geographic Education, National Geographic Press Office, 6/17/2011  
Coalition of Geospatial Organizations, Resolution on Geospatial Education  
([http://www.urisa.org/files/COGO\\_Education\\_Resolution\\_press\\_release%2006\\_02\\_2010.pdf](http://www.urisa.org/files/COGO_Education_Resolution_press_release%2006_02_2010.pdf))

## Opportunities to Utilize the DOL Geospatial Competency Model to Meet Federal/State/Local/Tribal Government Needs

By: Dave DiSera, Randy Johnson

### Background/Overview

The shortage of trained geospatial technology professionals reflects a number of issues among the geospatial profession and the industries it serves. Among these issues, geospatial technology is used in hundreds of fields, but despite its widespread adoption, there is a lack of awareness regarding geospatial technology in general and the related career opportunities. As a result, training and educational programs have been unable to meet the growing demand within both the public and private sectors. In addition, the skill sets and competencies needed to prepare for career opportunities in geospatial technology have not been well defined or understood. This has resulted in a lack of consistent curricula, standards, and credentials within the profession. A geospatial competency model can provide a common language among employers, educators, human resource professionals, and the like to address these issues.

The goal of a geospatial competency model and the data they provide is to help organizations better prepare for the future. If developed properly, a geospatial competency model can become an effective tool for performing gap analysis to assist in succession planning, knowledge management and transfer, employee development, and work or organizational change. Specific examples include:

#### Training and Development

- Identify existing geospatial competencies
- Evaluate and assess current employees to determine existence of geospatial competency gaps and surpluses
- Use coaching, mentoring, training, and recruitment methods that match personnel requirements and future needs
- Individual developmental planning

#### Workforce Planning

- Identify current and future human capital needs including workforce size, distribution, and competencies needed to achieve the geospatial needs of the organization
- Redeploy or temporarily rotate staff to fill some of the gaps
- Reorganizing or restructuring positions or organizations to make better use of existing geospatial resources and match skills to functions

#### Succession Planning

- Address skills needed to meet complexities associated with geospatial technology
- Identify, develop, and select successors who are the right people with the right skills
- Motivate and retain top geospatial talent

### Emerging Trends and Best Practices

#### Department of Labor's Geospatial Technology Competency Model

The U.S. Department of Labor's Employment and Training Administration (DOLETA) announced the release of an industry competency model for geospatial technology in July of 2010. The model is available on the Competency Model Clearinghouse available through the department's One-Stop Career Centers website. The **Geospatial Technology Competency Model (GTCM)** was developed to provide an employer-driven

framework of the skills needed for success in geospatial technology. The GTCM is a profile of the knowledge, skills and abilities required for the worker in the geospatial industry. The GTCM has been in development at the DOLETA since 2005, shortly after DOLETA highlighted geospatial technology as a high growth industry, along with biotechnology and nontechnology. These industries were also identified as having the greatest potential impact on the economy. <http://www.careeronestop.org/competencymodel/>

DOLETA worked with employer and education partners for two years to develop and validate a model that represents the broad range of services, technical and manufacturing professions, and products within the fields of geography, surveying and mapping, computer science, information science and other specialized areas of application that comprise geospatial technology. The GeoTech Center, a government, academia and industry partnership funded, in part, by a grant from the National Science Foundation and based at Del Mar College, led the validation process.

The model builds on previous efforts to describe geospatial industry skill needs, including the Geospatial Technology Competency Model developed at the University of Southern Mississippi. The new model groups competencies into foundational competencies, core geospatial competencies and competencies for three geospatial sectors: positioning and data acquisition, analysis and modeling, and software and application development.

The model is currently serving as a resource for career guidance, curriculum development and evaluation, career pathway development, recruitment and hiring, continuing professional development, certification and assessment development, apprenticeship program development and outreach efforts to promote geospatial technology careers.

#### **Geographic Information Science and Technology BoK2: Foundational Research Project**

The **Geographic Information Science and Technology Body of Knowledge** (GIST BoK) is a reference document produced by the University Consortium for Geographic Information Science (UCGIS) as the first product of its Model Curricula project. The GIST BoK is the most successful effort to date to create a comprehensive outline of the concepts and skills unique to the geospatial realm, including geographic information systems, geographic information science, remote sensing, satellite navigation systems, and cartography. It is also missing some topics, such as geocoding, and has significant granularity issues: large, mature subfields such as surveying, GPS, and remote sensing are covered in small sections. <http://www.ucgis.org/priorities/education/modelcurriculaproject.asp>

The follow-on project – called the GIS&T BoK2 -- will enable the maintenance and expansion of the knowledge base of GIS&T in a more dynamic, interactive, and collaborative manner than the original project. A new environment will be developed to provide for ways of understanding and experiencing the GIS&T Body of Knowledge and help to facilitate teaching, research, and professional advancement. Developing a common language was recognized early on and the University Consortium for Geographic Information Science (UCGIS) led the creation of the GIS&T BoK1. The GIS&T BoK2 project will:

- Map out the strengths and weakness of the BoK1 and develop a more comprehensive and inclusive organizing framework for GIST BoK2
- Examine a methodology for generating ontology
- Develop visually interactive representations of the Geographic Information Science and Technology knowledge domain
- Examine and test different environments for realizing the Bok2

The impact that the BoK1 has helped refocused educational and research activities in the GIS&T sector. The GIS&T BoK2 will create a dynamic environment for teaching, knowledge building, dialogue, collaboration, and research in GIS&T.

**Project GTCM**

**Project GTCM** is a national effort to develop curriculum based upon the Department of Labor's Geospatial Technology Competency Model by the Geotech Center. The objective of this project to develop a set of course pack outlines and assessment tools that allow community college educators to assess their own curriculum while developing new material, based upon industry standards. The Center is working to complete a "Model Geospatial Certificate" outline of courses and their required and recommended student learning outcomes content by late summer of 2012. <http://www.geotechcenter.org/Projects/Research-Projects/Geospatial-Technology-Competency-Model/>

**Opportunities and Challenges**

Starting as far back as the early 1990's, many organizations were having discussions about geospatial competency development and management within the GIS community. Over the years, many public and private organizations have struggled attempting to develop, implement, and effectively using a geospatial competency based system within their respective organizations. Understanding why this has happened and learning from the challenges of these organizations, is an important part of ensuring the success of the DOLETA's Geospatial Technology Competency Model going forward. While the excitement over the Geospatial Technology Competency Model has helped to fuel the sometimes-inflated expectations of its promise, there is not a quick and easy fix to the limited geospatial resources and lack of formalized competencies across the public and private sectors. The types of challenges that competency models and management have solved in other industries have evolved over the years. The complex problems associated with the application of geospatial technology don't have simple answers when you consider the accelerated use of geospatial data and technology, the continuing advances in technology, and the limitation of qualified resources, educational and training programs.

Before an organization begins looking at how to successfully apply the elements of DOLETA's Geospatial Technology Competency Model and implement a program for internal use, it is necessary for the organization to consider and build what is needed, use the right tools to make changes easy and dynamic, and respond to the organizational changing needs so that the program is both useful and used. Organizations need to address several pertinent questions before moving forward on a geospatial competency program initiative.

Question	Answer
Why are we developing a program?	To address the business value.
What will the program be used for?	To determine what geospatial lines of business or business processes it will support and manage.
What will the program include?	To define what elements are needed to make the program work.
How will the program be created?	To identify the process and procedures, and the resources necessary to implement and manage the program.

A successful geospatial competency program initiative will allow an organization to be consistent with what you hire geospatial resources for, train them in, what you measure performance against, and develop leadership potential. There are also opportunities in addressing the issues of demographics by developing new leaders, identifying where bench strength is lacking, and dealing with the retirement of experienced people in senior level positions. A program will also improve talent retention in today's highly competitive

market, and support employee-owned career development to further their competencies with geospatial technology.

### **Active Organizations and Their Focus**

The U.S. Department of Labor's Employment and Training Administration has lead development of 16 models, including the Geospatial Competency Model. These models are available on the Competency Model Clearinghouse available through the department's One-Stop Career Centers website. They serve as a resource for career guidance, curriculum development and evaluation, career pathway development, recruitment and hiring, continuing professional development, certification and assessment development, apprenticeship program development and outreach efforts to promote geospatial technology careers.

ETA worked with Geospatial employers, associations, and education partners for a period of two years to research, develop, and validate a model that represents the broad range of services, technical and manufacturing professions, and products within the fields of geography, surveying and mapping, computer science, information science and other specialized areas of application that comprise geospatial technology. The GeoTech Center, a government, academia and industry partnership funded, in part, by a grant from the National Science Foundation and based at Del Mar College, led the model validation process. It should be noted that the model builds on previous efforts to describe geospatial industry skill needs, including the Geospatial Technology Competency Model developed at the University of Southern Mississippi.

### **Recommendations**

The NGAC recommends that FGDC begin engaging appropriate federal agencies to identify opportunities to utilize the DOL Geospatial Competency Model to meet Federal/State/Local/Tribal government needs, by acting on the following:

- 2.1 The FDGC should collaborate with UCGIS and AAG to determine if the Body of Knowledge for GI Science and Technology's knowledge areas encompasses the breadth of the geospatial technology field from a government perspective.
  - Use the content of the BoK to construct a workforce survey where the current government geospatial workforce can validate and prioritize the content of the BoK.
  - Develop/adapt an introductory course or modules that provide the fundamental (core) geospatial skills as outlined in the BoK (or subsequent improved version of it) that are needed by the mainstream geospatial workforce across the government.
  - Create additional units under existing knowledge areas and create additional knowledge areas related to government workforce-driven applications for specific job classifications.
- 2.2 The FGDC should work with the geospatial community to develop a communication infrastructure and methods to facilitate geospatial information exchange, such as a website and e-mail list to facilitate communication.
  - Disseminate current information on professional geospatial development opportunities, training materials, tutorials and links to online resources.
  - Provide information about geospatial internship and mentorship opportunities.
  - Participate in and help coordinate GIS awareness events, such as GIS day and GIS education conferences.
- 2.3 The FGDC Secretariat should follow up with UCGIS and the Department of Labor on the status of the partnerships for developing mutual goals and programs to establish a clearinghouse for internship, work experience, and service learning programs; and the GeoTech Center on building

partnerships for developing a competency model for a program of study that provides guidelines for geospatial education programs for Federal government employees.

### Resources Reviewed and Related Links

Geospatial Technology Competency Model; US Department of Labor Employment and Training Program in conjunction with the GeoTech Center, 2010.

Geographic Information Science and Technology Body of Knowledge; David DiBiase, University Consortium for Geographic Information Science, Model Curricula Task Force, Body of Knowledge Advisory Board - Association of American Geographers 2006.

Secrets to Developing a GIS-Skilled Workforce; Lt. Col. Mike Wermuth and Lt. Col. Jeth Fogg; January – March 2006, ESRI ArcUser Online.

Defining the Components of the Geospatial Workforce—Who Are We?; Dr. Duane F. Marble, Castlereagh Enterprises, Inc.; Winter 2005 – 2006, ESRI ArcNew Online.

Geography Matter, an ESRI White Paper, September 2002.

Learning to Think Spatially; The National Academies, Report in Brief, July 2005

Integrating Geographic Information Systems and Remote Sensing for Technical Workshop Training at Two-Year Colleges; National Science Foundation, August 15 and 16 2005 Workshop Outcomes.

What is GIS: A Profession, Niche, or Tool? Geospatial Information & Technology Association (GITA) White Paper; June 2005.

Geospatial Technology Competency Model

<http://www.careeronestop.org/competencymodel/>

Department of Labor Employment and Training Program

<http://www.doleta.gov>

UCGIS Geographic Information Science and Technology Body of Knowledge

<http://www.ucgis.org/priorities/education/modelcurriculaproject.asp>

GeoTech Center – GTCM Page

<http://www.geotechcenter.org/Projects/Research-Projects/Geospatial-Technology-Competency-Model/>

United States Geospatial Intelligence Foundation

<http://usgif.org/>

United States Geospatial Intelligence Foundation – Accreditation

<http://usgif.org/education/accreditation>

National Geospatial Technology Skills Competition

<http://www.geotechcenter.org/Maps-Competitions/Competitions>

Competency Model Clearinghouse

<http://www.careeronestop.org/competencymodel/default.aspx>

Office of Apprenticeship, U.S. Department of Labor

[http://www.doleta.gov/OA/bul05/Bulletin%202005-08%20Occ%20\(lms\)-Occ-Geospatial%20Specialist.pdf](http://www.doleta.gov/OA/bul05/Bulletin%202005-08%20Occ%20(lms)-Occ-Geospatial%20Specialist.pdf)

## Updating “Externally” Focused [GIS Themed] SOC Standard Occupational Classification Codes and “Internally” Focused Federal Occupational Series Classifications

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### Background/Overview

Both the Department of Labor’s Bureau of Labor Statistics (BLS) and the Office of Personnel Management (OPM) produce occupational classifications which assist in federal, public, and private sector workforce development through the development of guidelines which outline general responsibilities, qualifications, and characteristics for particular fields of employment.

Occupational classifications focusing on geospatial workforce positions are found under both the BLS Standard Occupational Classifications, as well as under the OPM Federal Occupational Series Codes. The categories are as follows:

- BLS 17-2021 - Cartographers and Photogrammetrists
- BLS 17-3031 - Surveying and Mapping Technicians
- OPM GS-1370 - Cartographer
- OPM GS-1371 - Cartographic Technician

In an effort to guide recommendations, on behalf of the National Geographic Advisory Committee, regarding geospatial workforce development in public and private sector, a comparative analysis of both occupational codes is suggested to determine opportunities for revision. These revisions would focus on the sector areas where the occupational codes may best address recent changes in technology, operations, and current geospatial competencies.

### Emerging Trends and Best Practices

Existing occupation models in geospatial workforce development have relied on pairing positions to the occupational codes developed by BLS and OPM. Yet, as with many industries that have been impacted by advances in technology, workforce activities in the geospatial field have also been transformed by changes in technology regarding cartographic functions, operations, and services. Therefore, there is a significant opportunity to modernize the schedule of occupational characteristics to address changes in relevant technologies.

Emerging trends in geospatial workforce development have focused on the application of competency models as opposed to delineating a finite set of skills that may be performed at each occupational level. This has been advanced by the release of the Geospatial Technology Competency Model, developed by the Department of Labor’s Employment and Training Administration (ETA). The Geospatial Technology Competency Model accounts for all position levels within the geospatial technology sector and pairs each with respective competencies. The model provides for competency requirements for personal, academic, professional, technical, and managerial positions. The model demonstrates skills, critical work functions, and technical content areas respective to each competency level.

## Opportunities and Challenges

Position classifications often focus on specific skills, some which do not reflect current occupation-specific trends in technology. This includes both the BLS Standard Occupational Classifications and the OPM Federal Occupation Series Codes.

To address the changing requirements of the geospatial workforce, in both the public and private sectors, revisions to the occupational series codes should be made to reflect advances and changes in technology and industry practices.

These changes would reflect professional and technical work in the physical science sector encompassing of the cartography related positions under both sets of occupation specifications. With respect to professional and technical work, the skills, critical work functions, and technical content areas that may need revision include technology oriented services, operations, and functions. Many of these revisions will relate to understanding, operating, and managing computer-based Geographic Information Systems.

### BLS Standard Occupational Classifications

Potential changes or revisions to the BLS Standard Occupational Classifications may include the following:

#### 17-2021 Cartographers and Photogrammetrists

- Increase the number of illustrative examples to include GIS Technician and GIS related positions.

#### 17-3031 Surveying and Mapping Technicians

- Indicate there may be distinctions between physical and digital operations.
- Include provisions noting that surveying, mapping, and analysis functions may occur primarily in digital forms.

### OPM Federal Occupational Series Codes

Potential changes or revisions to the OPM Federal Occupational Series Codes may include the following:

#### GS-1370 Cartographer

- Include provision that mapping duties may occur primarily in computer-based GIS environments.
- Brief description of Geographic Information Systems as related to cartography duties.
- Include mention of orthographic imagery, aerial imagery, and satellite imagery, LIDAR, and other related technologies:

#### GS-1371 Cartographic Technician

- Indicate that many operations will occur as computer-based analyses and calculations.
- Include provisions noting that that many operations will occur in GIS environments.

Beyond the Standard Occupational Classification Codes and Federal Occupational Series Classifications listed above, the Subcommittee recommends that additional analysis be conducted to address additional occupations related to Surveying (Geomatics) and Geodesy as a “Phase 2” of this project for potential updates or changes.

## Active Organizations and Their Focus Areas

The **Bureau of Labor Statistics** at the **U.S. Department of Labor** sponsors SOC Standard Occupational Codes which briefly describe position characteristics, in respect to subject matter, responsibilities, and technical involvement. The SOC codes also include illustrative examples of likely positions under the classification, as well as the code relation to the SOC Broad Occupation, Minor Group, and Major Group. The SOC codes are intended for external use as a tool for position classification, as they do not include grading criteria for position grades within the federal government.

The **Office of Personnel Management** sponsors Federal Occupational Series Classifications which also account for position characteristics, in respect to subject matter, responsibilities, and technical involvement. The codes also include specifications as to the professional/ technical nature of the classification. Respectively, these specifications include grading criteria illustrations and factor level illustrations to determine position grades within the federal government. For this reason, Federal Occupational series Classifications are intended for internal use within the federal government.

The **Employment and Training Administration** at the **U.S Department of Labor** has developed the Geospatial Technology Competency Model. The model seeks to serve as guidance to help determine the responsibilities, skills, and technical proficiencies necessary at different grades of employment within the related family of geospatial occupations.

Figure 1 contains a table a comparison of workforce development model characteristics between the Standard Occupational Classification Codes, the Federal Occupational Series Classifications, and the Geospatial Competency Model.

### Recommendations

The NGAC recommends that FGDC work with the appropriate organization to update “externally” focused [GIS themed] SOC Standard Occupational Classification Codes and “internally” focused Federal Occupational Series Classifications, by acting on the following:

- 3.1 The FGDC should partner with the DOI Office of Human Resources to engage OPM in an effort to review, update, and modernize the geospatially-oriented Federal Occupational Series Codes (including the Cartography, Cartographic Technician, Surveying [Geomatics] and Geodesy series). The revisions to the Federal Occupational Series Codes should incorporate themes and approaches from the Geospatial Technology Competency Model.
- 3.2 FGDC, DOL, and the Federal human resource management community should collaborate with non-federal partners to encourage the use and adoption of the Geospatial Technology Competency Model and the updated Occupational Classification Codes and Series.
- 3.3 FGDC partner agencies should communicate with their academic partners about the revised occupational codes and competency model to facilitate development of appropriate training and curricula to address emerging geospatial workforce needs.

### Resources Reviewed and Related Links

Standard Occupational Classification, Bureau of Labor Statistics

<http://www.bls.gov/soc/2010/soc171021.htm>

<http://www.bls.gov/soc/2010/soc173031.htm>

Federal Occupational Series Classifications, U.S. Office of Personnel Management

<http://www.opm.gov/fedclass/gs1300p.pdf>

<http://www.opm.gov/fedclass/gs1300t.pdf>

Qualification Standards, U.S. Office of Personnel Management

<http://www.opm.gov/qualifications/standards/IORs/gs1300/1370.htm>

<http://www.opm.gov/qualifications/standards/IORs/gs1300/1371.htm>

Geospatial Technology Competency Model, Employment and Training Administration, U.S. Dept. of Labor

<http://www.careeronestop.org/competencymodel/pyramid.aspx?geo=Y>



Figure 1. Workforce Development Model Characteristics

## Summary of Recommendations

The following includes a summary of recommendations from each of the three white papers.

- 1. Identify synergies with the Administration’s Science, Technology, Engineering, and Mathematics (STEM) education initiatives, assess opportunities to incorporate Geospatial and Geomatics education into the four STEM categories, and assess potential role/involvement/support from FGDC and NGAC.**
  - 1.1 The FGDC leadership should work with and encourage CoSTEM to include geospatial technology and geomatics as components of the STEM disciplines.
  - 1.2 The FGDC Secretariat and agency members should review and comment on the results of the CoSTEM Inventory of Federal STEM Programs and the CoSTEM Report on Federal Coordination.
  - 1.3 The FGDC leadership should encourage awareness among FGDC member agencies regarding the importance of opportunities for geospatial technology related grants, such as the NSF’s Geography and Spatial Sciences Program and NOAA’s Cooperative Remote Sensing Science and Technology Center. Consider inviting NSF and NOAA to brief FGDC on how this model may be applied at other departments and agencies.
  - 1.4 The FGDC leadership should encourage FGDC member agencies to establish internship, fellowship programs, cooperative education, or exchange programs that give students practical understanding and real-world experience with geospatial technology and applications.
  - 1.5 The FGDC leadership should encourage FGDC member agencies to support geographic literacy through their respective education and outreach programs.
- 2. Utilize the DOL Geospatial Competency Model to meet Federal/State/Local/Tribal Government needs for assisting in succession planning, knowledge management and transfer, employee development, and work or organizational change.**
  - 2.1 The FGDC should collaborate with UCGIS and AAG to determine if the Body of Knowledge for GI Science and Technology’s knowledge areas encompasses the breadth of the geospatial technology field from a government perspective.
  - 2.2 The FGDC should work with the geospatial community to develop a communication infrastructure and methods to facilitate geospatial information exchange, such as a website to improve communication.
  - 2.3 The FGDC Secretariat should follow up with UCGIS and the Department of Labor on the status of the partnerships for developing mutual goals and programs to establish a clearinghouse for internship, work experience, and service learning programs; and the GeoTech Center on building partnerships for developing a competency model for a program of study that provides guidelines for geospatial education programs.
- 3. Update externally” focused [GIS themed] SOC Standard Occupational Classification Codes and “Internally” focused Federal Occupational Series Classifications.**
  - 3.1 The FGDC should partner with the DOI Office of Human Resources to engage OPM in an effort to review, update, and modernize the geospatially-oriented Federal Occupational Series Codes (including the Cartography, Cartographic Technician, Surveying and Geodesy series). The revisions to the Federal Occupational Series Codes should incorporate themes and approaches from the Competency Model.
  - 3.2 FGDC, DOL, and the Federal human resource management community should collaborate with non-federal partners to encourage the use and adoption of the Geospatial Technology Competency Model and the updated Occupational Classification Codes and Series.
  - 3.3 FGDC partner agencies should communicate with their academic partners about the revised occupational codes and competency model to facilitate development of appropriate training and curricula to address emerging geospatial workforce needs.

- <sup>i</sup> “Why STEM?” *Change the Equation*. 2011. <<http://www.changetheequation.org/why/why-stem/>>.
- <sup>ii</sup> “NSTC Committee on Science, Technology, Engineering, and Math Education.” OSTP. 2011. <<http://www.whitehouse.gov/administration/eop/ostp/nstc/committees/costem>>.
- <sup>iii</sup> “Geography and Spatial Sciences (GSS).” National Science Foundation. 2011. <[http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=5410](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5410)>.
- <sup>iv</sup> “CREST Research Overview.” NOAA-CREST. 2010. <<http://crest.cuny.cuny.edu/research/>>.
- <sup>v</sup> “Improving Science, Technology, Engineering, and Mathematics (STEM) Education. U.S. Department of Education. 14 February 2011. <<http://www2.ed.gov/about/overview/budget/budget12/crosscuttingissues/stemed.pdf>>.
- <sup>vi</sup> “Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future.” President’s Council of Advisors on Science and Technology. September 2010. <<http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf>>.
- <sup>vii</sup> “*Higher Education: Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends*.” Government Accountability Office. October 2005. <<http://www.gao.gov/new.items/d06114.pdf>>.
- <sup>viii</sup> “STEM-Designated Degree Program List.” Department of Homeland Security. 2008. <<http://www.ice.gov/sevis/stemlist.htm>>.
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- <sup>xi</sup> “No Child Left Behind Act of 2001.” Definitions: “Core Academic Subject.” 115 STAT. 1958. <<http://www2.ed.gov/policy/elsec/leg/esea02/107-110.pdf>>.
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- <sup>xiii</sup> “Geography 2010: National Assessment of Education Progress at Grades 4, 8, and 12.” National Center for Education Statistics. U.S. Department of Education. July 2011. <<http://nces.ed.gov/nationsreportcard/pdf/main2010/2011467.pdf>>.
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- <sup>xv</sup> “Education: Grad Schools.” *U.S. News and World Report*. <<http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools>>.
- <sup>xvi</sup> Phone discussion with a director for the GSS Program.
- <sup>xvii</sup> “NOAA-CREST Center Based At CCNY Receives Five-Year, \$12.5 Million Funding Commitment.” The City College of New York. <<http://www1.cuny.cuny.edu/prospective/gsoe/news/noaa-funding.cfm>>.