SUMMARY OF EXISTING RESOURCES

For the topic:
Defining and Communicating
Geospatial Technology Industry Workforce Demand

Draft working paper

Prepared by
Ivan Cheung (AAG) icheung@aag.org
&
Mary Ann Stewart (GITA) mastewart@sunfolower.com

***Disclaimer**: These are our collective impressions from the first roundtable and our thoughts about where we need to go on the second.*

INTRODUCTION & BACKGROUND

What is The President's High Growth Job Training Initiative?

This Presidential initiative is a strategic effort to prepare workers to take advantage of new job opportunities in high growth, high demand and economically vital sectors of the American economy. The program is sponsored by the U.S. Department of Labor, Employment & Training Administration (DOLETA). Thirteen targeted industries have been selected and three, including Geospatial Technology, have been identified as important emerging and evolving industries.

Emerging Industries

Biotechnology	**Geospatial Technology**	Nanotechnology

Industries

Advanced manufacturing	Automotive	Construction	Energy	Financial services
Information technology	Hospitality	Health care	Retail	Transportation

DOLETA has sponsored substantial initiatives in an effort to define the nature, industry growth and workforce requirements of the geospatial industry. Jennifer McNally, director of DOLETA's Business Relations Group, spoke at the October roundtable, providing some insight regarding how the geospatial industry came to be included as a high growth industry. She said that the origins were in the nation's reaction to 9/11 and the need to develop national disaster response capabilities, with the accompanying philosophy that community planning should be based on geospatial skills.

What are the objectives of this project?

This DOLETA funded year-long project is titled "A Pilot, Experimental and Demonstration Program for the High-Growth Geospatial Technologies Industry: Defining and Communicating Industry Workforce Demand." The objectives are:

1. To define the many and diverse geospatial industry components to help define the pipeline of characteristics and skills required to fill geospatial occupations, so that schools and One-stops can understand them and provide the necessary training;
2. To develop an effective and compelling public outreach program and informational materials about those industry components for distribution through existing DOL supported education and information channels, to address the lack of public awareness of geospatial technologies and their applications and to make a better connection between the geospatial industry and diverse populations of potential workers;
3. To pilot and demonstrate experimentally a new and innovative tool by which to provide current location-based industry worker demand information correlated with educational and workforce opportunities;
4. To pilot and demonstrate a specific application of these new outreach materials and geospatial intelligence information tools and methodology in a particular geographic area to better align educational, employment and economic development programs with employers' labor needs.

What are the objectives of this paper?

The ultimate aim of this paper is to develop strategies to build consensus among stakeholders/industry leaders with respect to the current and future trends of geospatial industry workforce demand. The specific objectives are:

1. To briefly summarize our collective impressions of the first thought-leader roundtable held in Washington, D.C. on October 6th 2005;
2. To present additional information and approaches to build consensus about industry definition, market segmentation, workforce demands, and challenges in meeting the demands.
3. To seek immediate feedback from a large group of stakeholders regarding critical the critical issues broadly defined above.

DEFINING THE GEOSPATIAL TECHNOLOGY INDUSTRY

Can we agree on one definition?

Although there is no consensus on a definition of the geospatial technology industry, the one developed by the Geospatial Workforce Development Center of the University of Southern Mississippi has been adopted by the Department of Labor (see Industry Profile, geospatial-profile-504.pdf). The geospatial technology industry is defined as

> "an information technology field of practice that acquires, manages, interprets, integrates, displays, analyzes, or otherwise uses data focusing on the geographic, temporal, and spatial context. It also includes development and life-cycle management of information technology tools to support the above."

The above definition was constructed for the purpose of developing a geospatial workforce competency model. "A definition was written by industry stakeholders early in the process to ensure participants answered questions from the same industry perspective. Research participants included those whose primary expertise and experience was remote sensing, as well as those with primary expertise and experience in GIS. Initial focus group discussions focused on the differences between remote sensing and GIS workforce requirements. However, during focus group session activities, participants recognized and determined that the workforce requirements were not remote sensing- or GIS-specific, but rather represented a broader industry domain they labeled geospatial technology." (Gaudet et al. 2004, p. 24)

To facilitate effective reaction to the above definition, the following relevant definitions are presented.

Geospatial Data & National Spatial Data Infrastructure (NSDI):

[Executive Order 12906 (1994) & 13286 (2003 Amendment)]

> "Geospatial data" means information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth. This information may be derived from, among other things, *remote sensing, mapping, and surveying technologies*. Statistical data may be included in this definition at the discretion of the collecting agency.
>
> "National Spatial Data Infrastructure" means the *technology, policies, standards, and human resources* necessary to acquire, process, store, distribute, and improve utilization of geospatial data.

AAG GIS and Science Special Group

Upon request, Distinguished Professor of Geography (Ohio State University), Mei-Po Kwan, also the current chairperson of AAG GIS & Science Special Group, provided the following definition.

> *"The industry that is concerned with the design, development, implementation and use of geographic information systems technologies. GIS technologies include a wide array of technologies, such as GIS software, global positioning systems (GPS), location-based services (LBS), mobile GIS, remote sensing, and Web GIS."*

UCGIS' The Strawman Report (2003)

> "The broad domain of GIS&T represents a body of knowledge that focuses in an analytic fashion upon various aspects of spatial and spatio-temporal information and therefore constitutes, in some of its aspects, a science. In other aspects, where the focus is largely upon the utilization of GI Science to attain solutions to real-world problems it has more of an engineering flavor with attention being given to both the creation and use of complex tools that embody the concepts of GI Science. The focus of GIS&T education is concepts and methods for geographic problem solving in a computation environment."

During our October 6th Roundtable, comments were wide-ranging and they include:

- Is "geospatial" an industry or a technology?
- Industry should be in the first phrase.
- The definition should address technology, information and personnel.
- Geospatial technology provides a basis for synthesizing.
- The geospatial industry acquires and uses geographic data and is a field of practice.
- The term GIS builds a fence. The general population doesn't understand. Geography isn't marketed well and needs professional help to find the right word for marketing the technology.

GEOSPATIAL MARKET SEGMENTATION

How do we break this cross-cutting industry into market sectors/segments for the purpose of assessing workforce demands?

Defining the market is extremely difficult given the current methods of record-keeping. The term "geospatial" or related terms do not appear in the 2002 version of the North American Industry Classification System (NAICS) or in the revisions that have been adopted for the 2007 version. The only specific codes that appear relevant are 54136, Geophysical Surveying and Mapping and 54137, Surveying and Mapping (other than geophysical). There is very little source material in terms of understanding the industry, let alone dividing it into segments.

There are potentially many ways to segment the geospatial industry. They all have merits and disadvantages.

What would work best for the purpose of collecting data about workforce demand?

The following methods may be useful.

Method 1:
Divide by technology sectors/components (the modified ASPRS approach)
Working definitions of these technologies are provided for reference purposes.

- Geographic Information Systems (GIS)
    a. **Geographic information systems** (GIS) are automated systems used to capture, edit, store, manipulate, analyze and display a variety of spatial data. A GIS has three major components: a data base, a spatial analysis and modeling capability, and a means for graphic display [ACSM]
    b. ***Geographic Information Systems (GIS)*** use the data collected from remote sensing and other technologies in mapping and other display methods to allow the analysis of climate and environmental conditions, description and network analysis of utility and transportation assets, legal descriptions of property through county plat mapping systems, and numerous other applications. [ASPRS]
    c. Others
- Remote Sensing
    a. ***Remote Sensing*** refers to the observation and collection of data without the sensor being in physical contact with the object being studied, such as the study of the Earth from distant vantage points, via satellite or aircraft. [ASPRS]
- Surveying & GPS
    a. ***Global Positioning Systems (GPS)*** is a geospatial technology that enables a portable handheld device to provide a precise location almost anywhere on the earth by processing signals with a constellation of satellites. [ASPRS]

- Mapping & Cartography
    a. **Cartography** is concerned with all aspects of the mapping process. It has artistic, scientific and technical dimensions. It includes the gathering, storage, retrieval, evaluation, and visualization of geographic information. It also includes the abstraction or generalization of data to suit the mapping scale, purpose and audience. [ACSM]
- Computer Aided Design (CAD)
    a. ***Computer Aided Design (CAD)*** is a computer-based system to support technically precise object and layout designs, such as architecture and engineering design applications of structures and other man-made facilities. [ASPRS]
- 3-D Imaging & Other Visualization Tools
    a. ***3-D Imaging and Other Visualization Tools*** provide the ability to display geospatial and other data in a computer environment that permits interactive examination and analysis of parameters, real-time display of monitoring information, simulations and other advanced technology.
- Information Technology (IT)
    a. The IT industry includes such products and services as software, telecommunications, wireless, Internet, hardware, peripherals, and computer and data services.
    [U.S. Bureau of Labor Statistics (BLS), Career Guide to Industries 2004-05].

<u>Method 2:</u>
<u>Divide by vertical markets (GITA approach)</u>

GITA divides the geospatial arena into six unique types of end users (vertical markets) in its annual Geospatial Technology Report. These sectors are electric, gas, water and wastewater, pipeline, telecommunications and public sector. Public sector participation in the survey which provides the basis for the report provides the largest response of the six industry types, representing 37% of all participants and exceeding participation of gas and electric utilities combined.

Another way to classify geospatial technology end users is into categories of traditional image analysts, traditional GIS users, users from other disciplines, mainstream business PC users and consumer and non-technical business users. The first two categories have predominantly specialized technical skills in handling geospatial information, while the users in the other categories have predominant expertise in their own subject matter areas and use geospatial technologies to enhance their business processes. Users in the latter three categories may have a wide range of geospatial technical expertise, ranging from very sophisticated to minimal capabilities.

Method 3:
Application/end user matrix (Adopted from Lo & Yeung 2002)

		Major Users						
		Government	Military	Education	Business	Non-Profit	Utility	General Public
Major Application Areas	Land & Resource Management							
	Environment							
	Census							
	Market Analysis							
	Surveying & Mapping							
	Engineering							
	Public Health							
	Health Services							
	Utility							
	Transportation							
	Facility Management							
	Geographic Data Browsing							
	Defense & Intelligence							
	Humanitarian							
	Emergency							

[Adopted & modified from Lo & Yeung, 2002, Figure 1.4, page 6; modified based on AAG research on how ESRI and Intergraph organize their products & services]

Method 4:
Divide by Organizational Structure (ACSM approach)

A Sampling of Organizations Using Cartography and GIS

Public Sector

- City and county Geographic Information Systems divisions
- State departments of natural resources
- State, county, and city planning commissions
- City and county public works departments, engineering, water and sewer agencies, emergency 911 centers, tax assessment departments, planning and zoning departments, land records, public access, transportation modeling and planning, and law enforcement agencies
- Federal government within various agencies

Private Sector

- Specialty mapping firms
- Newspaper and magazine publishers
- Televisions stations and networks
- Surveyors and land information companies
- Surveying equipment manufacturers
- Land development/housing market analysis firms
- Oil, electric and gas utilities
- Environmental consulting firms
- Health care firms
- Banks and insurance companies
- Transportation providers and consultants
- Real estate agents and brokers
- Retail organizations with multiple locations
- Telecommunications firms
- Software development companies
- Internet service providers
- Local and regional guidebook publishers

Non-Profit Organizations

- Environmental and civic organizations
- Schools and educational institutions
- Associations and journal publishers
- Professional societies and foundations
- International “think tanks”

GEOSPATIAL TECHNOLOGY INDUSTRY WORKFORCE NEEDS AND SKILLS/COMPETENCIES

Gewin (2004) reported that 26% of NASA's most highly trained "geotech" staff are to retire in the next decade while the National Geospatial Intelligence Agency (formerly NIMA) is expected to need 7,000 people trained in GIS in the next three years. On one hand these figures point to a bright future for those who want to enter the geospatial technology profession. On the other hand, such high demand of workforce need poses tremendous challenges to the geospatial technology industry and educational organizations. Furthermore, one specific goal of this project is to assess workforce needs across the United States, beginning at the state level. To do so, we must equip ourselves with a better system for collecting data about geospatial workforce needs.

Can we use the current BLS SOC system? If not, what recommendations can we provide DOL/BLS in the future?

The 2000 Standard Occupational Classification (SOC) system is used by Federal statistical agencies to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data (http://www.bls.gov/soc/home.htm). All workers are classified into one of over 820 occupations according to their occupational definition. To facilitate classification, occupations are combined to form 23 major groups, 96 minor groups, and 449 broad occupations. Each broad occupation includes detailed occupation(s) requiring similar job duties, skills, education, or experience. Traditionally, especially for well established and mature industries, the SOC system provides the basis for workforce demand projections. Unfortunately, for emerging industries the SOC system is inadequate for capturing the growth in workforce demand.

It is a huge challenge to address the issue of geospatial technology industry workforce needs when no coherent government statistics are kept. The Association of American Geographers (AAG) initiated an effort to identify occupations (using SOC) that are related to geographical education and training. A committee of experts identified 146 occupations (See Appendix A). It is important to note that not all of these occupations are directly related to the geospatial technology industry. However, as the geospatial industry is cross-cutting, these 146 occupations provide a broad sense of how the technology is integrated into many occupations. Perhaps an important step is to ask the industry leaders to identify and rank these 146 occupations in terms of relevance to the geospatial industry.

There are only three SOC occupations that can be directly linked to common job titles in the geospatial technology industry. These titles include Cartographers & Photogrammetrists (17-1021), Surveyors (17-1022), and Surveying and Mapping Technicians (17-3031). These three occupations are projected by BLS to grow by about 16,000 jobs between 2002 and 2012. To make use of the BLS SOC system, we must establish a method to link common geospatial job titles to these occupational titles.

What are the common job titles in the geospatial technology industry?

As a first pass at answering this question, on September 8, 2005, we extracted all job listings posted on the following online job resources (listed in the GITA career center URL http://www.gita.org/resources/careercenter.html): Directions Magazine, Earthworks, GeoCommunity, GISCafe, GISCareers, GIS Connection, GISjobs.com, GIS Jobs Clearinghouse, GIS Lounge, GeoSearch, GISUser.

There were a total of 336 job listings posted in the above URLs. All job titles were extracted "as is" and then modified to remove specific levels (such as "I", "II", "Senior", "Entry Level", etc) as well as vendor-specific software knowledge (such as "ArcObject", "ENVI", etc). This survey was aimed at making a quick observation of the most common job titles and functions. Of the 336 job listings, we identified a total of 176 unique modified job titles (see S:\Ivan\DOL2005\THOUGHT-LEADER-WS\whitepaper-draft\mod-title-sum.xls). It is important to note that some job listings use multiple job titles (such as "GIS Analyst/Programmer"). For the purpose of our analysis, we extracted both "GIS Analyst" and "GIS Programmer" as unique job titles.

The three most frequently used job titles are GIS Analyst (12%), GIS Specialist (19%) and GIS Technician (19%). No attempt at this point has been made to examine the difference between these three job titles in terms of their functionalities and responsibilities. We also examined the frequency counts of some commonly occurring terms used in these job titles (See Table 2). These terms are grouped coarsely into two groups: (1) Technology Component; and (2) Function/Role. The latter is very similar to the geospatial work roles identified by Cyndi Gaudet's work (see Table 2).

Table 1: Frequently used terms in the 336 job listings

Group	Term	Frequency Count
Technology Component	GIS, Geographic Information, Geomatics, Geospatial	174
	Photogrammetry+Photographer+Aerial+Image+Remote Sensing	28
	Survey, Geodetic	9
	Cartography, Map	6
	CAD or CADD	4
Function/Role	Engineering	24
	Software	16
	Analyst	78
	Specialist	46
	Technician, Technical	32
	Programmer	23
	Developer	29
	Application	11
	Database	12
	Manager, Management	39
	Marketing	6
	Sales	11
	Coordinator	12
	Training	4
	Professor	11
	Scientist	8
	Research	10

The lack of consensus regarding job titles is also apparent in state governments. Based on a quick glance at the 2005 NSGIS State Summaries (published in September 2005), many GIS jobs are classified as generic information technology (IT) and planner categories/series. Some states have specific GIS job classifications (such as the case in West Virginia, see http://www.state.wv.us/admin/personnel/clascomp/compindx/comp_g.htm). The following geospatial-specific job series are identified:

- Geographic Information System Database Administrator
- Geographic Information System Manager
- Geographic Information System Programmer Analyst
- Geographic Information System State Coordinator
- Geographic Information System Remote Sensing Analyst
- Geographic Information System Technician
- Geographic Information System Technical Administrator

What are the most desirable job skills and competencies? Is the University of Southern Mississippi's Geospatial Workforce Competency Model adequate in assessing the gap between what the industry needs and how the educational organizations train our workforce?

The ASPRS/NOAA/NASA Ten-Year Industry Forecast determined that the most difficult to hire job skills in the remote sensing geospatial information sector are, in order: applications developer, cartographer, software developer, cartographic technician, GIS applications analyst, and GIS technician. Respondents to their survey felt that the highest demand was in applications science in remote sensing using GIS, spatial database development and spatial statistics/analysis. They estimated that the narrower technological areas of hyperspectral sensing and multi-sensor fusion would likely to be in high demand in the future.

Beside technical skills (such as data management and programming), there is tremendous need for a successful geospatial professional to be broadly trained/educated in an academic discipline. This is reflected also in the 336 job listings discussed earlier. Many jobs are related to a specific discipline, such as geography, environmental science, risk analysis, landscape ecology, forestry, atmospheric science, and geology. This corresponds to the emphasis of the application component of the geospatial industry.

To date, the most comprehensive work related to geospatial workforce competencies has been conducted by the University of Southern Mississippi. (Gaudet et al., 2003) identified 12 roles that are not job descriptions, but groupings of competencies targeted to meet specific expectations of a job or function (See Table 2). Therefore, we caution that these roles do not correspond directly to those common job titles discussed above. Furthermore, these roles appear to cross the technological components of the geospatial technology industry. For example, "training" as a role can take place in an organization specializing in GIS as well as in remote sensing.

Table 2: Geospatial role definition

ROLE	**DEFINITION**
Application Development	Identify and develop tools and instruments to satisfy customer needs
Coordination	Collect geospatial and related data
Data Acquisition	Inter-organizational facilitation and communication
Data Analysis	Process data and extract information to create products, drive conclusions, and inform decision making reports
Data Management	Catalog, archive, retrieve, and distribute geospatial data
Management	Efficiently and effectively apply the company's mission using financial, technical, and intellectual skills and resources to optimize the end products

Marketing	Identify customer requirements and needs, and effectively communicate those needs and requirements to the organization, as well as promote geospatial solutions
Project Management	Effectively oversee activity requirements to produce the desired outcomes on time and within budget
Systems Analysis	Assess requirements for system capacities including inputs, outputs, processes, timing, and performance, as well as recommend necessary additions or adaptations
Systems Management	Integrate resources and develop additional resources to support spatial and temporal user requirements
Training	Analyze, design, and develop instructional and non-instructional interventions to provide transfer of knowledge and evaluation for performance improvement
Visualization	Render data and information into visual geospatial representation

Are the above 12 roles adequate in reflecting the rapidly changing workforce demand? Are these roles equally important in different organizations? Can you use these roles instead of job titles or SOC occupational titles for the purpose of projecting employment growth?

Gaudet et al (2003) also established a set of 39 geospatial technology competencies (see Table 3). They are divided into four groups and twelve competencies are identified as "core competencies".

Table 3: Geospatial Technology Competency Definitions

Group	Core	Geospatial Technology Competency Definitions
Analytical	YES	**Creative Thinking** – recognizing, exploring, and using a broad range of ideas and practices; thinking logically and creatively without undue influence from personal biases
Analytical		**Knowledge Management** – the efforts to systematically find, organize, and make available a company's intellectual capital and to foster a culture of continuous learning and knowledge sharing so that organizational activities build on existing knowledge
Analytical		**Model Building Skills** – conceptualizing and developing theoretical and practical frameworks that describe complex ideas in understandable, usable ways
Analytical	YES	**Problem-Solving Skills** – the ability to consider alternative courses of action and select and implement appropriate solutions
Analytical		**Research Skill** – selecting, developing, and using methodologies such as statistical and data collection techniques for formal inquiry
Analytical		**Systems Thinking** – identifying inputs, throughputs, and outputs of a subsystem, system, or suprasystem and apply that information to improve the application of geospatial technologies; realizing the implications of geospatial technology or many parts of an organization, process, or individual; taking steps to address the

		impact of applying these technologies
Business	YES	**Ability to See the "Big Picture"** – identifying trends and patterns that are outside a normal paradigm of the organization sources
Business		**Business Understanding** – demonstrating awareness of the inner workings of business functions and how business decisions affect financial or non-financial work results
Business		**Buy-in/Advocacy** – building ownership or support for change among affected individuals, groups, and other stakeholders
Business	YES	**Change Management** – helping people adapt to the changes brought on by new technologies and helping them to see the value and benefits of new technologies
Business	YES	**Cost Benefit Analysis/Return on Investment (ROI)** – understanding the relative costs of each geospatial technology, or combination of geospatial technologies and assuring that the organization is receiving a good value for the dollars spent on these technologies
Business		**Ethics Modeling** – modeling exemplary ethical behavior and understanding the implications of this responsibility.
Business		**Industry Understanding** – demonstrating awareness of the vision, strategy, goals, and culture of the geospatial technology industry
Business		**Legal Understanding** – ability to understand legal issues affecting the application of geospatial information technology
Business		**Organization Understanding** – seeing organizations as dynamic, political, economic, and social systems that have multiple goals; using this larger perspective as a framework for understanding and influencing events and change that can impact implementation and support of geospatial technologies
Business		**Performance Analysis and Evaluation** – the process of comparing actual and ideal performance in order to identify performance gaps or opportunities
Business	YES	**Visioning** – seeing the possibilities of "what can be" and inspiring a shared sense of purpose within the organization
Interpersonal		**Coaching** – helping individuals recognize and understand personal needs, values, problems, alternatives, and goals
Interpersonal	YES	**Communication** – applying effective verbal, nonverbal, and written communication methods to achieve desired results
Interpersonal		**Conflict Management** – helping people work together to resolve disputes through constructive processes and techniques
Interpersonal	YES	**Feedback Skills** – communicating information, opinions, observations, and conclusions so that they are understood and can be acted upon
Interpersonal		**Group Process Understanding** – understanding how groups function; influencing people so that group, work, and individual needs are addressed
Interpersonal	YES	**Leadership Skills** – influencing process of leaders and followers to achieve organizational objectives through change

Interpersonal		**Questioning** – gathering information from stimulating insight in individuals and groups through use of interview, questionnaires, and other probing methods
Interpersonal	YES	**Relationship Building Skills** – establishing relationships and networks across a broad range of people and groups
Interpersonal	YES	**Self-Knowledge / Self-Management** – knowing one's personal values, needs, interests, style, and competencies and being able to manage their effects on others
Technical	YES	**Ability to Assess Relationships Among Geospatial Technologies** – examining the effects of geospatial technologies on parts of an organization, as well as the effects on the organization's interactions with customers, suppliers, distributors, and workers
Technical		**Cartography** – organizing and communicating geographically related information in either graphic or digital form
Technical		**Computer Programming Skills** – being able to understand and use a set vocabulary and grammatical rules for instructing a computer to perform a specific task; knowledge of high-level languages; ability to create or revise a program
Technical		**Environmental Applications** – applying GIS technologies for environmental assessment or management purposes
Technical		**Geology Applications** – applying GIS technologies for geological purposes
Technical		**Geospatial Data Processing Tools** – knowing and being able to apply the skills needed to operate currently used geospatial data processing tools
Technical	YES	**GIS Theory and Applications** – understanding the theory behind GIS and being able to identify and implement modern day applications for it
Technical		**Photogrammetry** – recording, measuring, and plotting electromagnetic radiation data from aerial photographs and remote sensing systems against land features identified in ground control surveys, generally in order to produce planimetric, topographic, and contour maps
Technical		**Remote Sensing Theory and Applications** – understanding the underlying theories related to acquiring an object without contacting it physically such as aerial photography, radar, and satellite imaging
Technical		**Spatial Information Processing** – the process of modeling, examining, and interpreting model results necessary for evaluating suitability and capability, for estimating and predicting, and for interpreting and understanding
Technical	YES	**Technical Writing** – the ability to "translate" technical information to nonspecialists
Technical	YES	**Technological Literacy** – understanding and appropriately applying existing, new, or emerging technologies
Technical		**Topology** – understanding how map features represented by

points, lines, and areas are related, with specific emphasis on the issues of connectivity and adjacency of features

During the first roundtable event, only the technical competencies were distributed to the industry leaders and the responses were wide-ranging. In general, three main questions emerged during the discussion. First, do the four core technical competencies cover all the integral attributes of a successful geospatial professional? Second, why is there no discussion of the level of competency? Third, why are geological and environmental applications isolated as technological competencies? What about meteorological and hydrological?

How can we assess the geographic distribution of geospatial workforce demands?

At the minimum, we need to assess the geographic variation of geospatial workforce demands at the state-by-state basis. How do we begin to develop strategy to build a sustainable workforce if we don't know where these emerging careers and jobs are located? Currently there is no official data to form the basis of such assessment.

There are a few potential approaches:

- Estimate workforce demands based upon software product license counts at the state level (focusing on private sector stakeholders);
- Coordinate with other associations (such as URISA) to distribute surveys;
- Collaborate with associations such as NSGIC and NACo to gather workforce demand information from state and local governments.

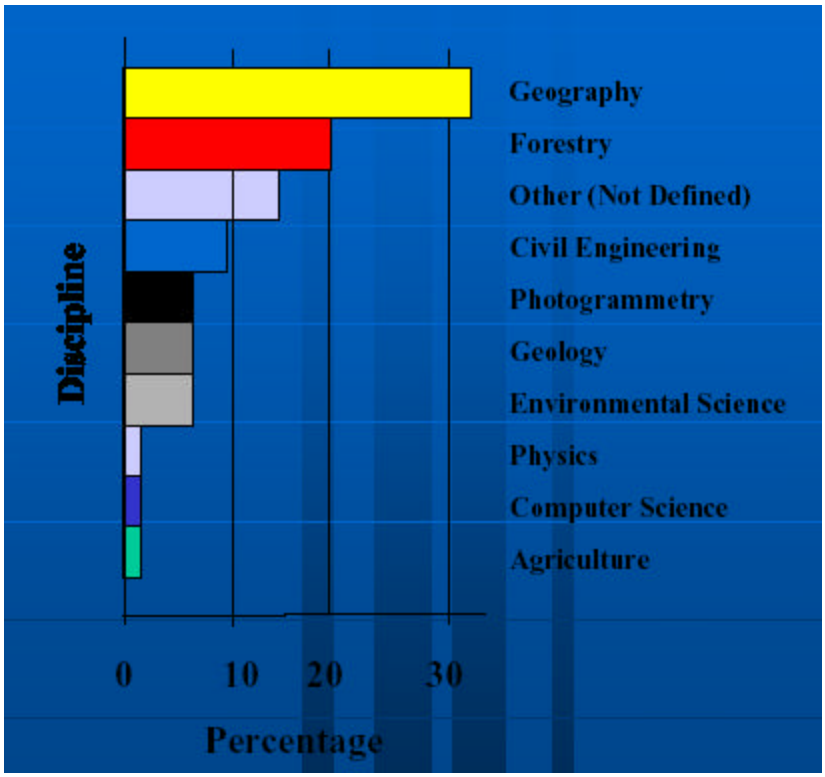
Meeting Workforce Demands

In what professional fields/academic disciplines do the geospatial professionals get their training and education?

According to ASPRS, by far the most common academic home of geospatial technology professionals is Geography. Over 30% of all professionals were trained in the field of geography (see figure 1). Similarly, the Urban and Regional Information Systems Association's (URISA) *Salary Survey for IT/GIS Professionals* also provides perspective on the composition of training for the market. The top five disciplines for educational degrees for the IT/GIS professionals surveyed were:

- Geography 41.5%
- GIS 23.7%
- Planning 11.8%
- Engineering 10.8%
- Computer Science 10.2%

Figure 1 (Graphic extracted from PDF-version of a presentation by ASPRS Plasker August 2005 @ NSF)



In the ASPRS/NOAA/NASA Ten-Year Industry Forecast (2001), it was noted that the most difficult to hire job skill is "applications developer" associated with the related academic disciplines of forestry, civil engineering, geology, environmental science, and geography.

What roles do the 4-year universities & 2-year community colleges play in meeting the rapidly increasing geospatial workforce demand?

BLS also provides projections of employment in 2012 by SOC titles (see Appendix A) as well as general training and educational requirements. The following table summarizes projected 2012 employment of all 124 occupations listed in Appendix A. This table shows that the majority of the projected jobs require some form of post-secondary education (ranging from associate to doctoral degree). In the occupations identified, just over 25% require on-the-job training (ranging from short, moderate, to long-term). The projected figures point to the continuing importance of the four-year university as well as the emergence of two-year community colleges.

Type of Training/Education Level	Total 2012 (1000)	%
Postsecondary vocational award	739	2.95
Associate degree	1133	4.52
Bachelor's degree	9636	38.40
Bachelor's plus experience	5600	22.32
Master's degree	849	3.38
Doctoral degree	30	0.12
Short-term on-the-job	4078	16.25
Moderate-term on-the-job	721	2.87
Long-term on-the-job	486	1.94
Work experience in a related occupation	1821	7.26
Grand Total	25093	100.00

How do we begin the process of closing the gap?

During the Oct 6th Roundtable event, many recommendations were advanced. The following bullet points are representative.

- The Gaudet competency model was developed because at the very beginning there was nowhere to go to get a list of the knowledge, skills and abilities for the industry. The intent of the model was to create a way to articulate knowledge skills abilities (KSA's) and get definitions for fields of practice. This area is still not black and white.

- It is harder to export health services, contrasted to technical services which are much more mobile. Historically the US has been labor short. Elsewhere it's different. There is a competitive battle going on, a struggle. This affects our field like other fields and takes us back to understanding the definition of the industry.

- One set of barriers comes from lack of commonly used job descriptions/titles.

- There has been a shift in the industry from lots of digitizing and data entry in the early stages, to current interests in data capture, automated data collection, and offshoring. Thus there has been a change in the nature of jobs. Integrative trends will transform the industry over next 10 to 20 years, resulting in a shift from GIS as a cartographic tool into core industries for decision making and planning. Employment will move out of the basement and into the boardroom. There will also be a trend to omniscient field-based systems.

- The geospatial industry doesn't have a process to strategically align with enterprise architecture. A talented GIS technician frequently has never been challenged in terms of presenting management information to the CIO.

- GIS people are more management oriented but we need to teach management to be more spatially literate.

- Where is IT in the geospatial industry? These groups need to be more integrated. Those championing GIS have to speak the language of the source of funding you need to secure.

- From a state and local government perspective, people are there and qualified, but there is rigidity in the classification system. It may be necessary to fall back to retrain people and adjust pay scales.

- From a Federal perspective there are standardized classification systems used by purchasing.

- There are issues with aging labor force, resulting in a need for life long learning to be coupled with short term needs.

- Some of the issues are with disruptive technologies. The education piece doesn't have the speed or budget to go into the leading edge technology.

- DOD pay grades and talent pools information will be shared in early December.

APPENDIX 1 -- List of occupations (SOC system) related to geographic education and training.

11-0000	**Management occupations**
11-1011	Chief executives
11-1021	General and operations managers
11-2021	Marketing managers
11-2022	Sales managers
11-3021	Computer and information systems managers
11-3051	Industrial production managers
11-3071	Transportation, storage, and distribution managers
11-9011	Farm, ranch, and other agricultural managers
11-9021	Construction managers
11-9032	Education administrators, elementary and secondary school
11-9033	Education administrators, postsecondary
11-9041	Engineering managers
11-9071	Gaming managers
11-9081	Lodging managers
11-9111	Medical and health services managers
11-9121	Natural sciences managers
11-9141	Property, real estate, and community association managers
11-9151	Social and community service managers
13-0000	**Business and Financial Operations Occupations**
13-1021	Purchasing agents and buyers, farm products
13-1022	Wholesale and retail buyers, except farm products
13-1023	Purchasing agents, except wholesale, retail, and farm products
13-1041	Compliance officers, except agriculture, construction, health and safety, and transportation
13-1061	Emergency management specialists
13-1121	Meeting and convention planners
13-2021	Appraisers and assessors of real estate
13-2053	Insurance underwriters
15-0000	**Computer and Mathematical Science Occupations**
15-1011	Computer and information scientists, research
15-1021	Computer Programmers
15-1031	Computer Software Engineers, Applications
15-1032	Computer Software Engineers, Systems Software
15-1041	Computer Support Specialists
15-1051	Computer Systems Analysts
15-1061	Database Administrators
15-1071	Network and Computer Systems Administrators
15-1081	Network Systems and Data Communications Analysts

15-2031	Operations research analysts
17-0000	**Architecture and Engineering Occupations**
17-1011	Architects, Except Landscape and Naval
17-1012	Landscape Architects
17-1021	***Cartographers and Photogrammetrists***
17-1022	***Surveyors***
17-2021	Agricultural Engineers
17-2051	Civil Engineers
17-2081	Environmental Engineers
17-2111	Health and safety engineers, except mining safety engineers and inspectors
17-2121	Marine Engineers and Naval Architects
17-2151	Mining and Geological Engineers, Including Mining Safety Engineers
17-2171	Petroleum engineers
17-3011	Architectural and Civil Drafters
17-3013	Mechanical drafters
17-3022	Civil Engineering Technicians
17-3023	Electrical and electronic engineering technicians
17-3024	Electro-mechanical technicians
17-3025	Environmental Engineering Technicians
17-3031	***Surveying and Mapping Technicians***
19-0000	**Life, Physical, and Social Science Occupations**
19-1010	Agricultural and food scientists
19-1023	Zoologists and wildlife biologists
19-1031	Conservation Scientists
19-1032	Foresters
19-1041	Epidemiologists
19-2021	Atmospheric and Space Scientists
19-2041	Environmental Scientists and Specialists, Including Health
19-2042	Geoscientists, Except Hydrologists and Geographers
19-2043	Hydrologists
19-3021	Market Research Analysts
19-3022	Survey Researchers
19-3041	Sociologists
19-3051	Urban and Regional Planners
19-3091	Anthropologists and Archeologists
19-3092	Geographers
19-3093	Historians
19-3094	Political Scientists
19-4011	Agricultural and Food Science Technicians
19-4041	Geological and Petroleum Technicians
19-4091	Environmental Science and Protection Technicians, Including Health
19-4093	Forest and Conservation Technicians
21-0000	**Community and Social Services Occupations**

21-1012	Educational, vocational, and school counselors
21-1022	Medical and public health social workers
21-1093	Social and human service assistants

23-0000	**Legal Occupations**
23-2093	Title examiners, abstractors, and searchers

25-0000	**Education, training, and library occupations**
25-1021	Computer science teachers, postsecondary
25-1031	Architecture Teachers, Postsecondary
25-1032	Engineering Teachers, Postsecondary
25-1041	Agricultural Sciences Teachers, Postsecondary
25-1043	Forestry and Conservation Science Teachers, Postsecondary
25-1051	Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary
25-1053	Environmental Science Teachers, Postsecondary
25-1061	Anthropology and Archeology Teachers, Postsecondary
25-1062	Area, Ethnic, and Cultural Studies Teachers, Postsecondary
25-1064	Geography Teachers, Postsecondary
25-1065	Political Science Teachers, Postsecondary
25-1067	Sociology Teachers, Postsecondary
25-1081	Education teachers, postsecondary
25-1111	Criminal justice and law enforcement teachers, postsecondary
25-1125	History Teachers, Postsecondary
25-1191	Graduate Teaching Assistants
25-1193	Recreation and fitness studies teachers, postsecondary
25-2021	Elementary School Teachers, Except Special Education
25-2022	Middle School Teachers, Except Special and Vocational Education
25-2023	Vocational education teachers, middle school
25-2031	Secondary School Teachers, Except Special and Vocational Education
25-2032	Vocational education teachers, secondary school
25-3021	Self-enrichment education teachers
25-4010	Archivists, curators, and museum technicians
25-9031	Instructional coordinators
25-9041	Teacher Assistants

27-0000	**Arts, Design, Entertainment, Sports, and Media Occupations**
27-3020	News analysts, reporters and correspondents
27-3031	Public relations specialists
27-3041	Editors
27-3042	Technical Writers
27-3043	Writers and Authors
27-4021	Photographers

31-0000	**Healthcare Support Occupations**
31-9093	Medical equipment preparers

33-0000	**Protective Service Occupations**
33-1012	First-line supervisors/managers of police and detectives
33-1021	First-line supervisors/managers of fire fighting and prevention workers
33-2022	Forest fire inspectors and prevention specialists
33-3021	Detectives and criminal investigators
33-3031	Fish and game wardens
33-9031	Gaming surveillance officers and gaming investigators
37-0000	**Building and Grounds Cleaning and Maintenance**
37-3011	Landscaping and groundskeeping workers
39-0000	**Personal Care and Service Occupations**
39-6021	Tour Guides and Escorts
39-6022	Travel Guides
39-6031	Flight attendants
39-6032	Transportation attendants, except flight attendants and baggage porters
39-9032	Recreation workers
41-0000	**Sales and Related Occuptions**
41-3041	Travel Agents
41-9021	Real estate brokers
41-9022	Real estate sales agents
43-0000	**Office and Administrative Support Occupations**
43-4081	Hotel, motel, and resort desk clerks
43-4181	Reservation and transportation ticket agents and travel clerks
43-5011	Cargo and freight agents
45-0000	**Farming, Fishing, and Forestry Occupations**
45-1011	First-line supervisors/managers of farming, fishing, and forestry workers
45-2092	Farmworkers and laborers, crop, nursery, and greenhouse
45-2093	Farmworkers, farm and ranch animals
45-4011	Forest and Conservation Workers
53-0000	**Transportation and Material Moving Occupations**
53-1011	Aircraft cargo handling supervisors
53-1021	First-line supervisors/managers of helpers, laborers, and material movers, hand
53-1031	First-line supervisors/managers of transportation and material-moving machine and vehicle operators
53-2011	Airline pilots, copilots, and flight engineers
53-2012	Commercial pilots
53-2021	Air Traffic Controllers
53-2022	Airfield Operations Specialists
53-5021	Captains, mates, and pilots of water vessels
53-6041	Traffic Technicians

55-0000	**Military Specific Occupations**
55-3015	Command and Control Center Specialists
55-3017	Radar and Sonar Technicians