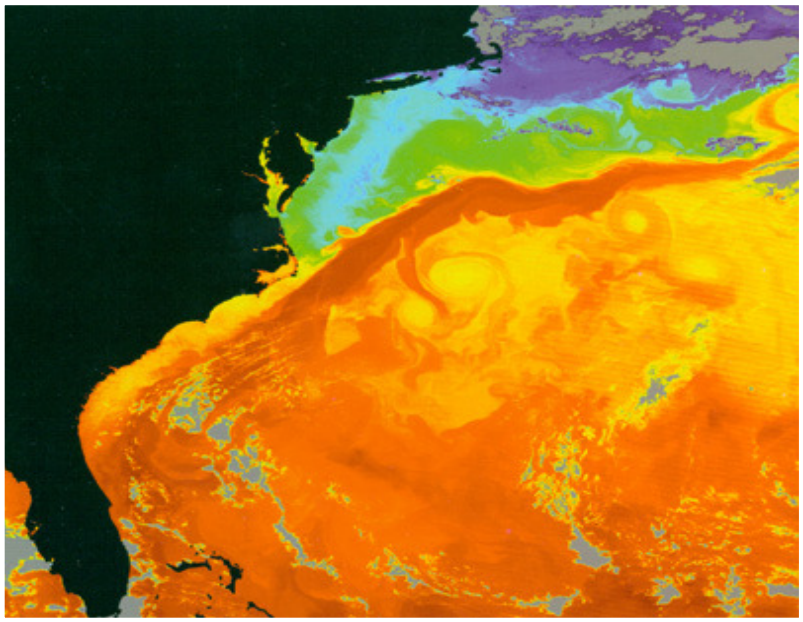
Identifying and Addressing Workforce Challenges in America's Geospatial Technology Sector



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High Growth Job Training Initiative

The U.S. Department of Labor
Employment and Training Administration

Preface

The High Growth Job Training Initiative is designed to provide national leadership for a demand-driven workforce system that ensures no worker is left behind. It is a strategic effort to prepare workers for new and increasing job opportunities in high-growth, high-demand, and economically vital industries and sectors of the American economy. Through this initiative, the U.S. Department of Labor (DOL) Employment and Training Administration (ETA) has been working with high-growth/high-demand industries, such as geospatial technology, to determine their key workforce challenges, and investing in demonstration projects that provide training in the higher and often technical skills required for individuals to get good jobs with good wages in the high growth industries.

The foundation of this initiative is the development of partnerships between the public workforce investment system, business and industry, and education and training providers, such as community colleges. The goals of this initiative have been to document the workforce development challenges and priorities of the demand side of the economy, and to propose innovative solutions that may fill gaps in education and training capacity of the targeted industries and help ensure the supply of qualified workers to these high growth/high-wage sectors.

The High Growth Job Training Initiative is a demonstration of ETA's commitment to long-term skills training and economic development in key high-growth sectors that will have a lasting impact on the American economy. To fully implement an effective training and development program for the geospatial industry, as for each of the targeted industries, ETA recognizes the need to sustain partnerships among industry, education, all levels of government, and the public workforce investment system.

This report presents the findings from an information gathering process that involved a variety of geospatial stakeholders reflecting on workforce issues and catalogs their proposed solutions. The report outlines the process where ETA, the geospatial technology business community, education, and government representatives formed partnerships and developed model solutions to address key workforce challenges.

DOL and ETA would like to thank the geospatial technology High Growth Job Training Initiative stakeholders for their leadership, commitment and participation in this process. Though not all stakeholders agreed with every model solution, recommendation, or option described in this document, the report has been made possible through their dedication to the challenges and the partnership model employed.

ETA is also pleased to have leveraged the substantial research and development work of the NASA National Workforce Development Education and Training Initiative team, making use of the significant Federal resources already invested and demonstrating federal agency cooperation and good government.

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Executive Summary

Growth Projections for the Geospatial Technology Industry

The geospatial technology sector has been selected as one of 14 targeted industries in the High Growth Job Training Initiative primarily because it currently meets many of the criteria for an emerging market sector, and is growing in additional areas as well. Geospatial technology shares concerns with the broader field of information technology and can learn from and contribute to the development of this field. The worldwide market for geospatial technologies has enormous potential. The most frequently quoted growth figures estimated the geospatial market at $5 billion in 2001, with projected annual revenues of $30 billion by 2005.[1] This growth is due to many factors, including the sector's importance to national economic and security interests.

As an emerging industry, geospatial technology encounters a variety of issues common to such sectors. There is not yet an industry-wide definition of the scope of the disciplines or the training and credentials required to work in the industry. There is no single organization tracking all relevant jobs within the geospatial industry and there are no comprehensive job descriptions or salary information for all relevant job opportunities.

Job opportunities in geospatial technology are growing in step with the needs of the industry. Along with this growth comes stress on the job market. A recent survey of geospatial product and service providers revealed that 87% of respondents said they had difficulty filling positions requiring geospatial technology skills.[2] General data provided by the Bureau of Labor Statistics (BLS) indicates that the architecture and engineering occupations group, including surveyors, cartographers, photogrammetrists and surveying technicians, which represent key geospatial occupational categories, is one of the occupational groups projected to have the fastest job growth from 2002 to 2012.

There is a lack of public awareness of the impact of geospatial technology applications on daily professional and personal activities. With greater understanding will come greater interest in entering the profession, as well as greater demand for geospatial capabilities and applications across a wide range of other sectors. The Geospatial Information & Technology Association (GITA) reports that approximately 70 to 80 percent of the information managed by business is somehow connected to a specific location—an address, street, intersection, or 'xy' coordinate. This interest in location is drawing geospatial technology into nearly every corner of the business world. Because the technology's uses are so widespread and diverse, the geospatial market is growing

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[1] Gaudet, Annulus, Carr, *Workforce Development Models for Geospatial Technology,* The University of Southern Mississippi, September 2001.

[2] DeRocco, Emily Stover. Speech to AACC & ACCT National Legislative Summit, February 10, 2004, Washington, DC. (www.doleta.gov/whatsnew/Derocco_speeches/AACC%20-%20Legislative.cfm)

at an annual rate of almost 35 percent, with the commercial subsection of this market is expanding at the rate of 100 percent each year. [3]

Education and Training in the Geospatial Technology Sector

Any emerging technology introduces challenges regarding education and training. The geospatial technology sector has historically been focused on four-year and advanced degree education. College preparatory courses that emphasize sciences are suggested for individuals interested in pursing careers in geospatial disciplines. However, to meet industry growth demands and requirements within the applications arena, employers need to explore alternatives to the traditional pipeline, including training provided by technical and community colleges.

The fastest emerging occupations within the geospatial technology industry require technical skills, yet the industry does not have enough training models or curricula to develop the necessary pipeline of skilled workers, creating significant gaps between workforce supply and demand. These gaps will likely grow unless there is a coordinated effort at the national level to study the issues, develop solutions, and implement them throughout the workforce. Recent estimates show the shortfall in advanced level of GIS-trained individuals to be around 3,000 to 4,000 in the U.S. alone, and the shortage outside the United States is even greater.[4] The few graduate programs now in place cannot meet the needs of the marketplace and the global demand will likely continue to grow faster than the supply of qualified graduates.

Many two-year academic and technical institutions offer education and training opportunities in photogrammetry, remote sensing, GIS, and related fields. Associate degree and certificate programs in GIS, surveying, photogrammetry, and similar curricula provide a sound foundation for many jobs or further education. For those who do not wish to pursue an advanced degree, there is a substantial demand for geospatial technology technicians. The Geospatial Technology Apprenticeship Program (GTAP) certification process now being developed and validated by ETA is intended to be a national, portable certification to help address this need.

General Findings

The High Growth Initiative is a three-phase process utilized to identify the workforce challenges of the Geospatial industry, as well as potential solutions. ETA engaged more than 182 individuals representing 111 geospatial technology sector organizations from 19 states and the District of Columbia, including members of industry (40%), education (21%), user groups (15%), associations and organizations, workforce professionals (3%) and government at all levels (21%) (Appendix B) throughout the high growth process. During the first phase, an environmental scan of the industry was conducted to provide a baseline for assessing the industry's workforce needs. ETA Assistant Secretary Emily Stover DeRocco convened an Executive Forum with leaders

[3] www.gita.org/about_gita/background.html

[4] Phoenix, Michael, "Geography and the Demand for GIS Education," *American Association of Geography Newsletter,* June 2000.

in the geospatial industry to learn more about the industry's workforce challenges. Industry leaders informed ETA that the geospatial industry is experiencing workforce challenges in three areas: skills, competencies and training; image and outreach to the public; pipeline (recruitment and retention)

ETA then hosted two Geospatial Industry Workforce Development Forums and one Geospatial Technology Workforce Solutions Forum. At the Workforce Solutions Forum over 50 geospatial technology stakeholders proposed some 146 solutions. During the Geospatial Technology Industry Solutions Development Forum, stakeholders developed 48 solutions matrices, or roadmaps (Appendix C & D).

Below are the three workforce challenges with some solutions identified by the group as priority solutions to address the challenges.

1. **Skills, competencies and training.**

During the forums there was agreement on the need to build basic spatial literacy and other business and interpersonal competencies, and that current practices for obtaining geospatial skills, competencies and training are insufficient. Stakeholders recommended mapping competencies to other sectors, industries and applications so the geospatial literacy gaps in these areas can be understood and addressed.

Potential Solutions for this challenge include the following. *Competencies Solutions:* Develop geospatial curriculum in schools. Develop on-the-job training. *Deployment Solutions:* Conduct small business workshops to determine needs and requirements; develop training based on user needs and nurture potential users. Deploy core training in K-12 and community colleges. Deploy specialized training tracks such as business administration, information technology, research and development and/or geospatial solutions. *Mapping Solutions:* Develop skill centers, community workshops, and training programs for decision makers and managers.

2. **Image and Outreach to the Public.**

Geospatial Technology stakeholders felt that due to the emerging nature of the technologies, that there was a lack of understanding of what is meant by geospatial by the public as a whole. They also indicated that the industry faces an image problem among youth. A concern was substantiated that youth viewed geospatial technology careers as less compelling and exciting than other information technology careers, thus creating a challenge in developing youth interest in this field..

Potential solutions for this challenge include the following. *Data and Definition Solutions*: Link resources of academia, industry and workforce boards to address the challenges of image and integrate resources to make greater impact. Develop a message that demonstrates geospatial technologies as an enabler of other location applications. Develop an academic and industry communications strategy. Create profiles of geospatial professionals to depict the industry with a human face.

3. **Pipeline.**

Stakeholders report that there is a lack of qualified individuals to fill current and projected job vacancies in the geospatial industry. They felt the industry must make a commitment to the recruitment of qualified workers and develop the support to enhance their retention. They reported an industry-wide need for professional development and general access to new labor pools as areas to focus.

Stakeholders identified the following potential solutions to address these challenges. *Recruitment Solutions:* Develop a national media campaign, including TV, radio, and magazine advertising, to bring more exposure to the technology, to increase public awareness, and attract potential workers. *Retention Solutions:* Develop a national system for certification, a stratification providing increased compensation, mobility across industries, and specific discipline/industry applications. Develop industry-specific survey tools to track salary, benefits, and best practices.

Next Steps

ETA supports comprehensive business, education, and workforce development partnerships to develop innovative approaches and replicate models that effectively serve the workforce needs of business while helping workers find good jobs with good pay and promising careers. Grants awarded under the High Growth Initiative are used by these partnerships to implement unique, industry-driven skills training, certification, and career ladder development programs that support identified geospatial workforce and economic development needs.

Based on the challenges identified by the geospatial technology sector and highlighted in this report, ETA has made a series of investments totaling more than $6.4 million to address the workforce needs in the areas of skills, competencies and training; image and outreach; and pipeline of prospective workers. The demonstration projects address the needs of the sector broadly as well as specific sub-sectors.

The next steps in this process include the implementation of these demonstration projects and sharing the successful models with the public workforce investment system so that their replication by other geospatial technology partnerships may ensure job growth for this key sector of the American economy.

ETA is committed to identifying employer-driven models through the High Growth Initiative and sharing them with the public workforce system. Sharing these models and resources will enable industry stakeholders around the country to develop effective partnerships that simultaneously help the geospatial technology industry address its key workforce challenges and help prepare workers to enter a high growth industry that is vital to the economy.

Introduction

Background

As an emerging technology sector, the geospatial industry lacks a commonly accepted definition describing salient qualities of the industry, its present activities, and projected trends. The best working definitions are largely descriptive in nature, generally attempting to characterize the entire sector from the perspective of one or another of the constituent industries or disciplines. However, there is growing consensus around capabilities and business uses that are representative of the geospatial industry.

Geospatial information is finding ever-increasing applications. The federal government uses it to manage forests, develop defense strategies, establish tax valuations and employ census data to determine voting districts. Utility companies use it to automate transmission and distribution networks and to build and service pipelines and communication networks. Cities are using geospatial technologies for applications as diverse as routing sanitation and emergency vehicles, replacing water mains, and matching equipment to job requirements. Private companies use geospatial information to make more informed decisions in areas ranging from site selection, to marketing demographics, to analyzing competition. Once a tool that was affordable only to the largest organizations, geospatial systems have become a cost-effective option for even the smallest organizations.[5]

Geographic Information Systems (GIS) are one type of geospatial technology that offers a radically different way to produce and use "maps" to manage communities and industries. The technology uses computer programs to link items displayed on a map with records in a database. This combination offers the ability to manipulate data in both a proactive and reactive manner, providing government agencies, utilities, and private industries with a powerful and dynamic planning and management tool. Once considered merely a means of better map production, GIS today is rapidly becoming an integral part of the management process across a broad range of sectors and applications.

A simple example of a GIS application is combining a map of city streets with latitude and longitude-referenced traffic flow data to create a map that reveals areas of frequent accident occurrence, potential detour routes, and even alternatives to improve traffic routing and alleviate rush hour stress. The same base map also may be reused to show, for example, changes in traffic patterns across time.[6]

The geospatial technology industry and workforce are complex in composition and outlook. The organizations dedicated to geospatial technology development and use are but one facet of this industry, with many new skill sets becoming embedded in

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[5] Geospatial Information Technology Association (GITA). *About the Technology.* (www.gita.org/about_gita/background.html).

[6] Markowitz, Kenneth J. "Legal Challenges and Market Rewards to the Use and Acceptance of Remote Sensing and Digital Information as Evidence," *12 Duke Environmental Law and Policy F219.*

applications and across disciplines, industries, and organizations. While many of these applications are still in the developmental stage and have not yet been widely adopted, the applications sector is growing rapidly, creating the need for thousands of positions ready to be filled immediately. This growth has been spurred by the perceived need for information gathering and improved decision making following September 11, 2001.

Slow workforce and human capital development are widely recognized as a potential barrier to ensuring widespread, long-term adoption and use of these technologies. According to the American Society of Photogrammetry and Remote Sensing (ASPRS) *Ten-Year Industry Forecast*, there are insufficient numbers of graduates with training in the latest technologies and techniques ready to enter the workforce.[7] The industry recognizes its need for improved communication to the public about the geospatial technology sector. As individuals, businesses and public sector organizations become more aware of the capabilities of geospatial technology and its contributions to everyday decision-making, even greater numbers of well-qualified workers will likely be sought.

There have been a few efforts to document geospatial technology workforce needs. In interviews for the *Ten-Year Industry Forecast*, corporate officers cited a shortage of trained workers emerging from educational programs and the lack of specifc required skill sets among many graduates. All sectors agree that an educated workforce is critical to the continued growth of the industry and its contributions to the economy. The *Industry Forecast* identified some of the positions that are most difficult to fill with qualified individuals: applications developer, cartographer, software developer, cartographic technician, GIS applications analyst, and GIS technician. Respondents reported that the highest demand was in applications science in remote sensing using GIS, spatial database development and spatial statistics and analysis. Finally, the U.S. Bureau of Labor Statistics projects that the architecture and engineering occupations group, which includes surveyors, cartographers, photogrammetrists, and surveying technicians who are considered part of the geospatial industry, will be one of the top 10 fastest growing occupational groups 2002 and 2012.[8]

GITA's Industry Trends and Analysis Group (ITAG) Report for 2005 identified a number of workforce issues. There is a need to revise existing university curricula and develop new curricula to expose the industry infrastructure and GIS technology. For example, applications and the value of GIS need to be introduced into a number of engineering disciplines. It is important to broaden the geospatial network to include multiple industries, universities, and university disciplines. Education and training must be linked with careers and jobs, and training programs must keep up with the needs of this dynamic industry and the larger economy.[9]

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[7] Mondello, Charles; Hepner, Dr. George R.; Williamson, Dr. Ray A. "Ten Year Industry Forecast." *Photogrammetric Engineering and Remote Sensing,* January 2004.
[8] U.S. Bureau of Labor Statistics quoted in DOLETA High Growth Industry Profile for Geospatial Technology.
[9] GITA. *Industry Trends and Analysis Group (ITAG) Final Report 2005.*

About This Report

This report summarizes the process used to propose solutions to address the geospatial technology sector's workforce development challenges. It is divided into four major sections:

Section I: Background on Workforce Issues summarizes the key elements and trends in the geospatial technology industry.

Section II: The High Growth Job Training Initiative describes the process by which the High Growth Job Training Initiative engaged the geospatial technology sector.

Section III: Geospatial Technology Workforce Challenges and Solutions discuses geospatial technology workforce development needs, challenges, and priorities, and also stakeholder-proposed solutions for ETA to consider when making strategic demonstration investments.

Section IV: Implementation of Solutions and Conclusion describes ETA's investments in potential solutions and offers concluding comments.

The High Growth Job Training Initiative for the geospatial technology sector is not a comprehensive evaluation of the marketplace or workforce issues, rather a snapshot in time of the views and recommendations of the broad based geospatial technology stakeholder community.

Section I: Background on Workforce Issues

Overview of the Geospatial Technology Sector

According to a report prepared by the Geospatial Workforce Development Center at the University of Southern Mississippi, 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.[10]

What are Geospatial Technologies?

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.

Geographic Information Systems (GIS) provide users the ability to display and manipulate data with interactive mapping software. GIS allows users to query a database to perform spatial analysis or communicate specific information about a location. Data gathered and provided through GIS applications can be tailored to perform critical functions in many disciplines, such as agriculture and land management, utility service and design, and intelligence gathering and analysis.

Positioning Systems (GPS) employ a geospatial technology that enables a portable device to pinpoint a precise location almost anywhere on the Earth by processing signals with the aid of satellites.

Geospatial technology stakeholders identified four key producers and users of the geospatial technology sector:

Geospatial industry suppliers are technology, systems, hardware and software developers and manufacturers, as well as data suppliers who analyze raw geospatial data and develop products and services that convert the data into meaningful information for use by other industries. These firms work in any or all of the remote sensing, GIS and GPS technology-related fields.

The federal government was largely responsible for the development and utilization of geospatial technologies during the Cold War. The industry (both private sector and public) substantially depends on federal funding, resources, policies and input for direction and growth.

State and local governments are among the largest users of geospatial information for planning, economic development, and land use management. Increasingly, they are turning to geospatial applications for critical infrastructure protection and emergency preparedness and response tasks.

[10] Annulis and Gaudet. "Strategies—Outcomes—Support: A Geospatial Workforce Development Seminar." May 24, 2005.

Private industry owns the majority of the nation's infrastructure of electricity, water, gas, pipelines, and telecommunications. Assets range from electric poles to sewer lines to wireless communication towers. Utilities use geospatial data management and analysis capabilities for asset management, outage management, design, workforce management, regulatory compliance, and a host of other functions.

Secondary users can be found in any market, sector, industry or organization that utilizes geospatial information to improve decision-making, business, or organizational efficiency. These users of geospatial technology and applications may not intuitively characterize their industries as geospatial, but would say that their business model calls for key information that is obtained from geospatial sources.

Examples of Secondary Users	Application Areas
Utilities Industry	Electric, Gas, Water, Pipeline, Telecommunications
Engineering	Civil Engineers & Surveying
Transportation Industry	Logistics, Transportation Systems and Networks
Government	Disaster Management, National Security, Epidemiology, 911 Response, Economic, Development, Elections, Land Records and Cadastral Solutions, Law Enforcement, Public Safety, Sustainable Development, Urban and Regional Planning
Environmental	Climate Change, Weather Modeling, Urban Modeling, Waste Disposal, Environmental Enforcement
Business	Financial services, Real Estate, Legal, Insurance, Retail and Commercial Business, Mass Media, Entertainment
Natural Resources	Agriculture , Archaeology, Forestry, Marine and Coast Mining and Earth Science, Petroleum, Wetlands, Watersheds
Education	Universities and Community Colleges, K-12, Primary, Middle and Secondary, and Libraries and Museums

Spatially enabled information can help solve business problems within a utility in areas including: asset management, emergency preparedness, site selection, customer service, compliance, land management, logistics, operation, mobile workforce, finance, marketing, environmental, engineering and demographic analysis. In addition, business processes in every department of a utility can benefit from the integration of GIS analysis and visualization to support decision-making and communication in areas such as economic development, marketing, inventory management, debt management, employee management, fleet management, and risk management.[11]

[11] ESRI Web page comments www.esri.com

Engineers who would ordinarily be limited to computer aided design (CAD) data can now see how their work relates to environmental issues, marketing concerns, and land ownership. Repair crews en route to remote sites, who in the past had no way of knowing the terrain over which they were driving, are now given GIS-generated information about access routes and areas to avoid, along with details about their destination and the nature of the repair required there. GIS gives planners of a new pipeline or power station a wide-angle view of the system their project connects.[12]

Size of the Geospatial Technology Sector and Projected Growth

The emergent nature of the geospatial technology sector has made it particularly challenging to characterize the geospatial marketplace and compile workforce related data. According to NASA's National Workforce Development Education and Training Initiative (NWDETI) 2001 Business Implementation Plan, the job market demands approximately 75,000 GIS skilled workers per year. The spatial technologies industry has more than doubled over a four-year period, creating enormous demand.[13] Association studies on various sub-sectors of the geospatial industry, such the ASPRS/NOAA/NASA *Ten-Year Forecast* of the remote sensing industry, or URISA's *Salary Survey for IT/GIS Professionals* and *Model Job Descriptions for GIS Professionals*, offer a variety of analyses.

The BLS Occupational Outlook Handbook describes the following geospatial professions:[14]

Land surveyors establish official land, air space, and water boundaries; write descriptions of land for deeds, leases, and other legal documents; define airspace for airports; and measure construction and mineral sites.

Cartographers compile geographic, political, and cultural information and prepare maps of large areas.

Photogrammetrists measure and analyze aerial photographs that are subsequently used to prepare detailed maps and drawings.

Surveying technicians assist land surveyors by operating surveying instruments and collecting information in the field, and by performing computations and computer-aided drafting in offices.

Mapping technicians calculate mapmaking information from field notes, draw topographical maps, and verify their accuracy.

Geographic information specialists combine the functions of mapping science and surveying into a broader field concerned with the collection and analysis of geographic data.

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[12] Dangermond, Jack in Preface to Christian Harder's *Enterprise GIS for Energy Companies,* ESRI Press, 1999.
[13] National Aeronautical and Space Administration (NASA). "Imaging Tomorrow: NWDETI Business Implementation Plan," Stennis Space Center, Office of Education. 2002.
[14] U.S. Department of Labor, Bureau of Labor Statistics. *Occupational Outlook Handbook—Surveyors, Cartographers, and Photogrammetrists and Surveying Technicians.* 2004-05 Edition.

Another approach to occupational classification in the geospatial technology industry makes distinctions within the geospatial technology end user community who are often traditional image analysts, traditional GIS users, users from other disciplines, mainstream business PC users and consumers, and non-technical business users. The first two groups have primary specialized technical skills in handling geospatial information, while the users in the other groups have primary expertise in their own subject matter areas and use geospatial technologies to enhance their business processes. Users in the latter three groups may have geospatial technical expertise ranging from very sophisticated to minimal.

The Department of Labor's Geospatial Industry Profile provides the following projections of 2000-2010 growth for geospatial-related occupations:[15]	
Architectural and Civil Drafters	+20.8%
Cartographers and Photogrammetrists	+18.5%
Civil Engineering Technicians	+11.9%
Electrical and Electronic Engineers	+10.8%
Electrical Drafters	+23.3%
Environmental Engineering Technicians	+29.1%
Geoscientists	+18.1%
Industrial Engineering Technicians	+10.1%
Mechanical Drafters	+15.4%
Mechanical Engineering Technicians	+13.9%

The *Ten-Year Industry Forecast* for the remote sensing industry concludes that An estimated 175,000 people are employed in the U.S. remote sensing and spatial information industry. It is a rapidly growing segment of the much larger information industry. Growth in the remote sensing industry is expected to be approximately 9% annually over the next few years.

The majority of firms in the industry are relatively small, having less than 100 employees. The many smaller firms are less able to support internal research and development and workforce development, are more affected by governmental competition with their services, and are less able to meet foreign competition.

[15] Department of Labor Geospatial Industry Profile

The age structure of workers in the geospatial technology industry is segmented into older experienced workers and younger employees who are new to the industry. The data from the much smaller segment in the mid-career range may infer that younger employees are leaving the industry for better opportunities, creating a potential shortage of mid-level personnel.

Sales estimates for the sector appear to be fairly consistent. Technology market research firm Daratech estimates that sales of GIS software totaled $2.2 billion in 2004, up 9.7% from the previous year. Worldwide spending on GIS software, hardware and services totaled $7.7 billion in 2001.[16] Another market research firm, IDC of Framingham, Massachusetts estimates that worldwide spending on GIS software in 2004 was $1.8 billion, of which $544 million was spent by U.S. federal, state and local government agencies.

There are ample opportunities for growth in diverse market segments. Growth is likely in traditional applications for mapping, civil government, national defense and global security, as well as newer applications that address the needs of local and state government for homeland security, environmental assessment, and infrastructure.

Why the Geospatial Technology Sector Will Grow

The Open GIS Consortium Vision Statement suggests that, "Approximately 80 percent of business and government information has some reference to location, but until recently the power of geographic or spatial information and location has been underutilized as a vital resource for improving economic productivity, decision-making, and delivery of services."[17] Another estimate suggests that 75 percent of business data has some type of geospatial content, but less than 10 percent of businesses use such data in a traditional geographic context.[18] And a recent National Academy of Public Administration (NAPA) study estimates that geographic information plays a role in about one-half of the economic activities of the United States.[19]

The BLS *Occupational Outlook Handbook for 2004-05* says that employment of surveying and mapping technicians is expected to grow faster than average through 2012. The short training period to master operating the equipment, the absence of formal testing or licensing, the growing demand for basic GIS-related data-entry work, and relatively lower wages all fuel demand for these technicians. Growth in the use of GPS and GIS may also enhance employment opportunities for surveyors and surveying technicians who have the educational background and technical skills to work with the new systems.

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[16]Phoenix, Michael, "Geography and the Demand for GIS Education," *American Association of Geography Newsletter,* June 2000.

[17] Open Geospatial Consortium. "Vision Statement."(www.opengeospatial.org/about/?page=vision

[18] Frost & Sullivan. *World Remote-Sensing Data and GIS Software Markets,* Mountain View, CA, 1999.

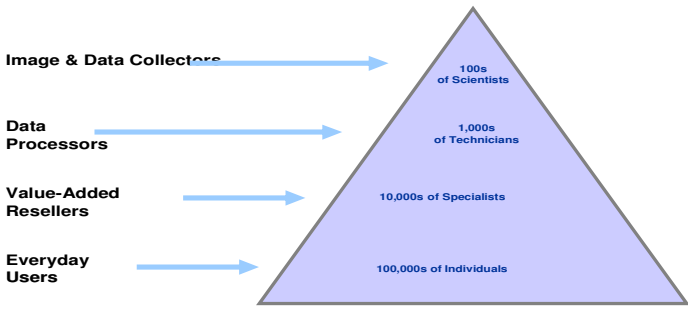
[19]National Academy of Public Administration (NAPA). *Geographic Information for the 21st Century.* Washington, DC. January 1998.

Opportunities for surveyors, cartographers, and photogrammetrists should remain concentrated in architectural, engineering and related services firms. Nontraditional areas, such as urban planning, emergency preparedness, and natural resource exploration and mapping, will likely experience employment growth as they produce maps for the management of emergencies and engage in updating maps with the newly available technology. Continued growth in construction through 2012 will require surveyors to lay out streets, shopping centers, housing developments, factories, office buildings, and recreation areas, while setting aside flood plains, wetlands, wildlife habitats, and environmentally sensitive areas for protection.[20]

A survey conducted by American Forests found that GIS technology has been adopted by many public agencies throughout the U.S. The 1996 survey of 200 cities with greater than 25,000 residents and counties with greater than 50,000 residents, reports that 40% of those local governments had adopted GIS technology, with 87% indicating that they would have the technology by the end of that year. An earlier survey in 1995 by the International City/County Management Association found a 23% adoption rate in municipalities and counties, with an additional 32% considering implementation (out of 1400 respondents).[21]

As demonstrated in Figure 1: Geospatial Supply Analysis, the ultimate driver of growth is likely to be everyday users, a category which potentially includes the entire population who may be using embedded geospatial technologies such as car navigation systems and Web-based mapping and imagery display applications. An important trend fueling the industry's growth is increasing adoption of GIS technology by organizations previously unacquainted with GIS.[22]

Figure 1: Geospatial Supply Analysis



[20] U.S. Department of Labor, Bureau of Labor Statistics. *Occupational Outlook Handbook—Surveyors, Cartographers, and Photogrammetrists and Surveying Technicians.* 2004-05 Edition.
[21] Huxhold, William E. (Department of Urban Planning, University of Wisconsin-Milwaukee). *Certifying GIS Professionals.* URISA presentation. (www.urisa.org/GIS_CERT_PRES/sld002.htm)
[22] Francica, Joe. "MapQuest.com Serves Map to the Masses, *Business Geographics*, May 2000.

Current Employment in the Geospatial Technology Sector

In the Spring 2005 *Occupational Outlook Quarterly*, the U.S. Bureau of Labor Statistics provided May 2004 employment figures for workers in the geography-related professions. There were 9,870 cartographers and photogrammetrists; 52,680 surveyors; 60,530 surveying and mapping technicians; 750 geographers; 425,890 computer applications software engineers; 96,960 database administrators; and 31,140 urban and regional planners. Others who are trained in geospatial technology work in the related occupations of computer applications software engineers and database administrators. More distant, but still related, occupations pursued by individuals with geospatial technology training include: business, real estate development, tourism, forestry and conservation science, geomorphology, climatology, and social science geography.

DOL's *Occupational Outlook Handbook* notes that architectural, engineering and related services firms provide about two-thirds of the jobs listed above. Federal, state, and local government agencies provide almost one in six jobs. Major federal employers are the U.S. Geological Survey (USGS), the Bureau of Land Management (BLM), the Army Corps of Engineers, the Forest Service (USFS), the National Oceanic and Atmospheric Administration (NOAA), the National Geospatial Agency (NGA), and the Federal Emergency Management Agency (FEMA) within the Department of Homeland Security. Most surveyors on state and local government staffs work for the highway department or urban planning and redevelopment agencies. Other employers include utilities, construction firms, mining, and oil and gas extraction companies.[23]

ESRI, a leading GIS software vendor, estimated in September 2005 that it had 300,000 client sites with more than 1 million users in over 200 countries around the world. While approximately 40 percent of the users are international, that number is growing rapidly as distributors become more successful and as ESRI completes more enterprise-wide agreements with global companies.[24]

Salary Information in the Geospatial Technology Sector

The Bureau of Labor Statistics (BLS) reports in its Spring 2005 *Occupational Outlook Quarterly* median annual earnings of $46,080 for cartographers and photogrammetrists, $42,980 for surveyors, $30,390 for surveying and mapping technicians, $58,970 for geographers, $74,980 for computer applications software engineers, and $53,450 for urban and regional planners.

A number of geospatial technology sector stakeholders have suggested that BLS data, although reporting national median salaries, often does not tell a meaningful story regarding opportunities in geospatial businesses and does not attract workers. They have expressed concern that the presentation of the data could do just the opposite, adversely impacting marketing to prospective employees. They have suggested

[23]U.S. Department of Labor Bureau of Labor Statistics. *Occupational Outlook Quarterly*. Spring 2005.
[24]Theodore, Jesse. ESRI Marketing, Redlands, CA. (email response to query)

combining the use of BLS data with industry-developed data. According to URISA data, the majority of private-sector GIS salaries are in the $60,000 to $69,999 range followed by the $40,000 to $49,000 range. While not disputing BLS data, such a presentation may be more appealing from a marketing perspective. In addition, the use of industry-generated job titles and descriptions for emerging professions, as alternatives to the general categories in the profiles, may enhance marketability. URISA's *Model Job Descriptions for GIS Professions* provides job descriptions within categories based on job responsibilities of managers, coordinators, specialists, programmers, analysts, and technicians.

Education and Training in the Geospatial Technology Industry

Currently, most geospatial technology occupations emphasize four-year and advanced degrees. The ASPRS study found that remote sensing and GIS programs are most often offered in departments or colleges of geography, natural resource management, forestry, and civil engineering. The interactive website created by the American Association of Geographers (AAG) (www.aag.org/Education/Intro.html) maps geography departments in the U.S. and Canada. The University of Southern Mississippi's GeoSpatial Workforce Development Center catalogs U.S. two-year and four-year programs in the U.S. at geowdc.com/root/united_states/us_map.htm. ESRI also has an online university database of colleges and universities with GIS programs at gis.esri.com/university/onlinedb.cfm

This traditional approach to education may not be most efficient for training the geospatial workforce of the future. Over the past few years, some two-year and vocational technology level training programs have emerged to support the growing need for geospatial technicians. There is also increasing interest in alternative education models, such as apprenticeships and certification programs, as these afford flexibly to respond quickly to changes in technology and skills requirements. Additionally, there is a growing demand for professionals trained in a variety of disciplines where geospatial technology could be applied, ranging from engineering, to the sciences, and to business.

DOLETA has found that apprenticeship training is, for some occupations, one of the more effective tools for preparing workers. The Geospatial Technology Apprenticeship Program (GTAP), under development by the University of Southern Mississippi (USM), will provide portable geospatial technician apprenticeship certification. GTAP combines theoretical classroom learning with on-the-job training and learning environments. The success of the effort relies on strong partnerships among several Mississippi-based geospatial businesses, NASA, ETA, USM and several local community colleges. USM is now in the process of reaching out to other potential communities and businesses to begin model replication.

URISA, ASPRS and the Board of Registration for Professional Engineers and Land Surveyors have developed certificate programs over the last 15 years. The URISA

Certification Committee was established in 1998 to develop professional certification in each of 23 disciplines. In 2004, the GIS Certification Institute (www.gisci.org) began offering a certification process for GIS professionals. Advocates believe that GIS certification will protect the public, grow the GIS profession, increase and ensure competency of GIS professionals, instill ethical behavior, and provide assistance to employers.

One of the often-stated goals of GIS certification is to assist employers with hiring decisions and personnel management and development. There is concern, however, that certification not be erroneously treated as a licensure and become a requirement in procurements. Much of the pressure for certification comes from individuals who think it will be a useful credential in building their careers and establishing professional credibility. Some believe that GIS professionals will be paid more once the profession is 'recognized' and that it may be a useful credential for demonstrating an individual's expertise.

A growing body of research points to benefits of using GIS to enhance student learning, despite implementation challenges such as teacher training in GIS software. In addition, innovative lessons are being developed by and for educators at all levels. For example, Thomson Brooks-Cole Publishing offers three GIS exploration books on the dynamic Earth, tropical cyclones, and water resources at www.brookscole.com/earthscience_d/; and the Missouri Botanical Garden has posted Mapping the Environment curricula at www.mobot.org/education/mapping/;[25]

A study conducted at the University of Wisconsin-Madison reports that photogrammetry, remote sensing, and GIS, once considered separate areas of study, today enjoy an increasing degree of conceptual and technological symbiosis. These formerly exotic technologies have become critical to the conduct of science, government, and business. What is becoming a new geospatial information paradigm has led to multifaceted changes at the University in everything from courses, curricula, research program, and technology transfer activities to changes in administrative and financial arrangements. Such holistic restructuring may position users to reap additional opportunities from geospatial information education and training.[26]

Continuing education is also an important source for training and staying current with the newer technologies. A 2004 survey by the online magazine, GeoPlace, found that one third of respondents reported that association workshops are the best source for continuing education and training. Vendor seminars came in a close second with 29 percent, followed by university courses at 13 percent, continuing education at 8 percent, and webcasts at 4 percent.[27]

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[25] Kerski, Joseph. "Titanic Exploration with GIS." *Geospatial Solutions*. May 2004.
[26] Lillesand, Thomas; Timothy Olsen, James Gage, Patrick McEnaney, "New Paradigm, New Approaches: Restructuring Geospatial Information Education and Training in a Traditional Research University Setting," *IAPRS*, Vol. XXXIII, Amsterdam, 2000.
[27] GeoPlace survey. (www.geoplace.com/uploads/georeport/040303.htm) 2004.

Section II: The High Growth Job Training Initiative

The High Growth Job Training Initiative seeks to provide national leadership to a demand-driven workforce system that ensures no worker is left behind. It is a strategic effort to prepare workers for new and increasing job opportunities in high-growth/high-demand and economically vital industries and sectors of the American economy. The initiative seeks to ensure that worker training and career development resources in the public workforce system are targeted to helping workers gain those skills and competencies required to obtain jobs and build successful careers in these industries.

The High Growth Job Training Initiative for the Geospatial Technology Industry

The High Growth Job Training Initiative for the geospatial technology sector was largely an outgrowth of NASA's National Workforce Development Education and Training Initiative (NWDETI), developed at NASA's John C. Stennis Space Center in Mississippi. The NWDETI is a customer-driven model, designed to close the gap between the geospatial industry's economic potential and workforce needs, and available jobseekers who lack the necessary qualifications. A key element of the NWDETI model is the reliance on existing education and training infrastructure to deliver the services needed for a trained geospatial workforce. At the same time, NASA has invested more than $4 million in the initiative. Through NWDETI, NASA and the public workforce system have leveraged one another's investments to greatly increase the overall return.

The High Growth Initiative proceeded through three phases: Information Gathering, Research and Analysis, and Implementation.

Information Gathering and Executive Forums

The initial phases of information gathering started during February and March 2003, with the development of a geospatial technology industry environmental scan (Appendix F), the cataloguing and evaluation of existing workforce development and market information, other external research, and one-on-one meetings with key NASA NWDETI leaders and other potential federal partners, including the U.S. Departments of Commerce and Education. The Geospatial Executive Forum was held on April 10, 2003, at the National Space Foundation National Symposium in Colorado Springs, Colorado. ETA Assistant Secretary met with seventeen senior executives from industry and government to inaugurate a dialogue with key decision-makers and stakeholders to identify geospatial workforce needs and challenges. In Additional ongoing data gathering opportunities included NASA's National Workforce Development Education and Training Initiative Informal Program Review Panel meeting August 13-14, 2003, conference calls and one-on-one meetings with key industry and government stakeholders and an online validation with forum on proposed solutions and next steps for the geospatial High Growth Job Training Initiative (Appendix E).

Geospatial Industry Workforce Solutions Forums

On April 10, 2003, ETA held a Mini-Workforce Development Forum in Colorado Springs, Colorado, with seven industry human resources professionals to discuss workforce challenges and priorities and seek a commitment to continue in the dialogue. On July 24-25, 2003, ETA hosted a larger Workforce Development Forum in Washington, DC where the ETA Assistant Secretary met with 30 senior executives and human resources professionals representing industry, academia, the public workforce investment system and government. Participants contributed more detail regarding geospatial technology workforce needs and challenges, considered causes of the needs and challenges, and developed priorities and a plan to address them. On March 9, 2004, more than 50 stakeholders representing industry, users, academia, the public workforce investment system and government developed "model solutions" to address the geospatial technology sector's workforce development priorities at the Geospatial Industry Workforce Solutions Forum. This session utilized a modified outcome-based nominal group facilitation process to develop solution matrices containing key solution attributes, partners, resources needed, and possible policy barriers. During the Geospatial Technology Industry Solutions Development Forum, some 146 solutions and developed 48 solutions matrices, or roadmaps (Appendix C & D).

Section III: The Geospatial Technology Sector's Workforce Challenges and Solutions

Each challenge and solution matrix presented below is designed to serve as a road map to fully develop a model solution. Geospatial technology stakeholders proposed more than 146 solutions and selected twelve of these for priority consideration. The solutions focus primarily on the key partnerships, tactics, and approaches to address the geospatial technology sector's workforce development challenges. A proposed solution is an innovative workforce development strategy or model with positive outcomes that can be implemented, sustained and replicated at the local, regional or national level. Participants worked in groups to brainstorm and prioritize innovative workforce solutions, propose foundational models, and document the critical attributes, key stakeholders, resources, implementation barriers and other pertinent information in a "solutions matrix" to guide ETA's investments in high growth industry strategies.

Each workforce challenge is labeled and briefly described. There follows, a brief summary of significant issues and observations. Proposed solutions follow, grouped according to the schema of: 1) competencies solutions, 2) deployment solutions, and 3) mapping solutions.

Challenge 1: **Skills, Competencies, and Training**	**Description:** Skills, competencies, and training encompasses the areas of education and training resources, tools and approaches to evaluate, develop, and implement solutions to meet the skill requirements for geospatial technology workers
Issues and Observations	
There was broad agreement among stakeholders that the geospatial technology industry requires core competencies in the areas of business, interpersonal skills, technical, and analytical skills. While individual organizations may require some variation of competencies and may seek to ensure the required competencies differently, stakeholders believed that a focus on core competencies is critical to ensuring a well-trained workforce. Smaller firms also have limited funds for on-the-job training. Stakeholders look to educators to deliver new, integrated curriculum programs to meet future needs.[28] They noted a particular need for training for day-to-day imagery manipulation and analysis and development of GIS data layers and mapping projects. Other observations included: 1. Occupational titles are inadequate. 2. There is a need for clear classifications for a family of geospatial technology jobs. 3. There are only the beginnings of certification in the geospatial technology sector. 4. A better understanding is needed of appropriate titles and pay scales for individuals working in geospatial professions. 5. There was little awareness in the industry of the publicly funded workforce investment system. 6. Determining the type and method of training delivery could involve deployment decisions. 7. Deployment decisions could also be required in developing flexible apprenticeship approaches. 8. Evaluating the competencies in the geospatial technology user community could be of great value in planning training.	

Proposed Solutions: **Skills, Competencies, and Training**	Stakeholders participating in the skills, competencies and training group identified 42 potential solutions in three broad categories: 1) competencies; 2) deployment; and, 3) mapping. They developed 15 solutions matrices, which are summarized below:
Competencies Solutions	
1. **Develop geospatial**	Stakeholders discussed the importance of developing content standards for geospatial skills,

[28] Mondello, Charles; Hepner, Dr. George R.; Williamson, Dr. Ray A. "Ten Year Industry Forecast." *Photogrammetric Engineering and Remote Sensing,* January 2004.

curricula in schools.	developing qualified instructors, and identifying existing instructional models. Other needs include a certifying body, accessible training, certified curricula and a champion to help institutionalize the implementation process. **Stakeholders labeled this solution a priority.** Stakeholders also mentioned that the NWDETI helped foster curriculum development in Mississippi and by 2005, every student in the state in grades seven to nine will receive coursework in geospatial technologies. Senior high school students will also be offered a geospatial science elective. Several leading software vendors are actively working with school districts nationwide to provide access to geospatial technologies and tools for the classroom. NASA Connect also offers an annual series of FREE integrated math, science and technology programs for students in grades 6–8. These and other ongoing efforts to develop and influence local curriculum should be leveraged wherever possible. Stakeholders noted that the public workforce investment system could serve as a vehicle to link these initiatives.
2. **Develop on-the-job training.**	This solution calls for building on OJT models that already exist; **it was labeled a priority by the stakeholders**. It would require non-four year programs, modular training, appropriate customized applications, centers for excellence to deliver the training, on-the-job training (OJT) curriculum development, apprenticeship development and cross disciplinary curriculum. OJT models are being developed by the GTAP and other high technology apprenticeship efforts. Stakeholders mentioned that customizing the OJT to meet specific applications or needs of particular users (defense intelligence, urban planning) or categories of workers (transitioning workers) may be valuable.
3. **Develop programs specific to GIT competencies into public sector training.**	This solution would be on improving the effectiveness of incumbent workers, which was discussed at length by stakeholders as a key issue. ETA is currently discussing how to better utilize Workforce Investment Act investments for incumbent worker training. This solution would require non-four year programs, modular training, appropriate customized applications and centers for excellence to deliver the training. Before being trained, the trainer must understand the technology's applicability. The University Consortium for Geographic Information Science curriculum has developed materials for different levels of competency (www.ucgis.org).
4. **Develop competency standards used by GIT integration**	Stakeholders outlined certification standards, multiple levels of trainers, users, and business owners, and trainer and train-the-trainer curricula. Standards for trainers and teachers are critical to ensuring quality education opportunities in geospatial and related disciplines. Some of the more effective local partnerships could be engaged in identifying skills needs and metrics for

trainers within target groups.	train-the-trainer initiatives.
Deployment Solutions	
5. Conduct small business workshops to determine needs/requirements, training based on user needs and nurture potential users.	This solution calls for qualified trainers, qualified curriculum, broad recognition by the community, a follow-up process (implementation/issues/usage), performance metrics, and reasonable or low cost. Understanding who would conduct the workshops is a potential barrier. **The stakeholders labeled this solution a priority.**
6. Deploy core training in K-12/ community colleges. Deploy specialized training tracks such as business administration, information technology, research and development, and/or geospatial solutions.	This solution calls for qualified trainers, qualified curriculum recognized by a broader community, a follow-up process (implementation/issue/usage), performance metrics, teaching transferable skills rather than jobs or occupations, training including hands-on field work, and incorporating geospatial technologies into existing course work. There are significant and varied resource requirements. Barriers include state certification requirements (a new course is often a barrier), state mandated credits, creation of new curriculum and new degrees, gaining security clearances, long delays in process and conflict of regulations for immigration vs. security issues. Stakeholders also suggested specialized training tracks selected to meet the local workforce needs or as part of a comprehensive approach. They pointed out that this solution could be married with the skills center approach and was **identified it as a priority**.
7. Create training programs that include classroom and field training.	This solution envisions people using an application in the field, forging agreements with the existing user community, and directing classroom and field experience toward problems that are more real and less purely theoretical. The barriers include government data sharing issues, privacy issues, need for equipment for field testing/data collection, and WIB requirements (local level demand occupations). This solution could also provide community service opportunities through projects in the field. Several stakeholders suggested replication of the model of the EAST initiative, which has implemented high tech applications development projects for community service in K-12. It was noted that this model could leverage the Geospatial Technology Apprenticeship Program and other OJT programs.
8.	Stakeholders discussed the need for information tools that are widely available, widely known,

Develop or improve a portal for jobs, education and training programs.	easy to navigate, tied into existing portal systems, include powerful and easy ways to add new content, self-maintaining, and employing a standard format for content. Barriers include WIB requirements, WIA interpretation and reaching consensus. While www.careervoyages.gov is intended to meet many of these objectives, stakeholders were uncertain whether a site subject to some governmental requirements could meet the need for this kind of web site portal. The site should be flexible and easily updated. The Geospatial Workforce Development Center at The University of Mississippi, NASA and other private vendors maintain websites and information that should be leveraged (www.geowdc.usm.edu).
9. **Establish a geospatial coordinator at local one-stops.**	Though the **workgroup labeled this a key solution**, it but did not fully develop a solution matrix. ETA believes that this solution could catalyze outreach and awareness of geospatial fields and more effective use of the public workforce investment system. An option for executing this solution could be through local one-stops, depending on local buy-in and local geospatial technology workforce development needs. Through partnerships with states and local workforce boards, this solution seems viable.
Mapping Solutions	
10. **Develop skill centers, community workshops, and training programs for decision makers and managers.**	This solution requires skills development such as GIS, remote sensing and GPS; stakeholder groups that help define what skills are delivered; a resource gap analysis; qualified instruction; decisions on where training will take place; customizable training for walk-in clients; an assessment of skills and additional skills needed; benchmarking current use; connections to the geospatial industry to stay up to date; basic spatial literacy training; a national organizational scope; instructional centers that are WAN enabled; and the ability and capacity to support the evolution of geospatial technologies. Barriers include coordination and information sharing among the public and private sector and academic institutions. **The stakeholders identified this model solution as a priority**. This solution promotes the local and regional coordination and integration of E ^{3} resources around skills training and applications development. Model centers could focus on specific applications areas and issues of expertise. It could also be part of a broader user or applications strategy.
11. **Host community forums for sharing**	This solution would require greater knowledge of applications than of particular data, awareness building, training for existing jobs, sharing best practices, and distance learning. Barriers include

existing geospatial information.	copyrights on information. Stakeholders saw these as a means to reach user audiences and build awareness of the potential of the technology, as well as stimulate discussions about user skill set needs.
12. Define business functions and evaluate where those functions are performed.	This strategy calls for identifying business, product delivery, and production information functions; outreach to the business community and user community; a cross walk of the GTCM to identify common tasks; and listing of the skills that are required. No barriers were identified. The group suggested that this model should be federally sponsored. There was a great deal of discussion during the Geospatial Technology Solutions Development Forum regarding the need to promote the use of spatial technologies in an enterprise setting. This kind of approach promotes the integration and coordination of many business functions around spatial data and applications.
13. Create a reference guide.	This calls for easy access to easily maintained and updated information that is web based, linked to other sources of information, and provided in other languages. It would require criteria for information to be included and a timeline for completion; it could be related to one stop job posting of geospatial resumes and include links to potential educators and employers. Barriers include information sharing and a finished product online tutorial. The group also suggested that this be piloted as a regional approach and that possible uses of such a resource by training providers should be explored in developing this solution.
14. Identify target industries for training.	This solution would follow after the sequence of building skill centers and hosting community workshops. Feedback from the workshops would clarify needs; then industries and applications for training could be targeted.
15. Develop a national strategy for a geospatial non-profit.	While the workgroup did not develop this solution, the notion of a not-for-profit could be important when considering sustainability strategies and alternative funding streams. Participants recommended that such a solution could also be part of a skills center concept.

Challenge 2 **Image and Outreach to the Public**	**Description:** Image and Outreach to the Public is comprised of strategies, tactics, models, initiatives, campaigns and efforts to build awareness and improve the industry image among key audiences (youth, teachers, community colleges and technical schools, universities, the military, public and private sector user organizations and groups, and incumbent, dislocated, and transitioning workers) regarding the development, use, applications and societal benefits of geospatial technologies.
Issues & Observations	
One of the most urgent concerns expressed by the executives was improving the image of their industry. Stakeholders suggested that the central barrier to improving the sector's overly technical image is most likely the lack of a widely agreed upon and comprehensive industry definition. Such a definition would enable the establishment of metrics and the collection and assessment of data against those metrics that could tell a positive story about employment benefits and opportunities in the geospatial technology sector.	
Proposed Solutions: Image and Outreach to the Public	The image and outreach participants suggested 55 solutions, but focused their development of solution matrices on four priority solutions having to do with "definition and data." The 18 matrices provided different approaches to the four priority solutions and two additional areas of focus.
1. **Develop a workgroup to develop and validate the conceptual industry model using a consensus approach to define the geospatial industry.**	Stakeholders suggested identifying or developing a sponsoring organization with vested stakeholders comprised of industry representatives. Concerns identified include organizational barriers and possible resistance from U.S. Departments of Commerce and Labor. The Geospatial Technology Competency Model (GTCM) developed by USM and NASA already engaged a multi-stakeholder industry group to build consensus on a definition of the industry . Some stakeholders expressed interest in utilizing the GTCM definition as starting place, but believed it should be revised to include elements or sectors of the industry were left out of the definition. Agreement on a definition should include the E^3 partnership if it is to become a workable solution.
2. **Develop a task force/advisory group to "vet" programs and spending.**	This solution requires a clear mandate from the U.S. Secretary of Labor, active participants, and input from industry. Potential barriers include Workforce Investment Act Reauthorization, higher education policies, and insufficient input from industry. Stakeholders mentioned that this solution could be linked to the previous solution or other approaches to improving the industry's image. Any such advisory group should be related to

	all other High Growth sectors. Additionally, a group of this nature would likely fall under the Federal Advisory Committee Act, which could impose complicating requirements.
3. Develop a message that demonstrates geospatial as an enabler of other location applications.	This solution requires a clear description for the layperson concerning geospatial technology, including the business case for various users or applications. A barrier could be budget constraints. Message development to specific audiences is a typical element of strategic communications planning; it is an essential component of the industry and academic communications strategy outlined below, and also the national campaign discussed in the pipeline section. The group suggested that the public workforce investment system could be a distribution channel in addition to other channels mentioned: web, marketing skills and career counselors.
4. Develop an academic and industry communications strategy with federal, state and local partners identifying skills required and mapping to industry standards.	There were common themes cutting across all of the solutions, including a decision making process based upon understanding industry skills requirements, evaluating the gaps, mapping to national standards, and openly communicating the results. The different approaches all involve multiple stakeholders and require significant funding and human resources for development and execution. The barriers identified include proprietary or confidential data, and lack of consensus on industry roles. Attendees discussed the need to leverage NASA's investment in the Geospatial Technology Competency Model. Outreach efforts should be directed to include foundations as a potential resource. The group also emphasized that two-way communication is a critical factor in a successful communications strategy.
5. Create profiles of geospatial professionals to humanize the industry.	These matrices call for creating real, practical and high visibility examples of geospatial professionals and applications in action, including key information that would attract young people and other workers to enter to the geospatial field. Political priorities and funding are identified as barriers. Stakeholders thought it important to reach out to a variety of target audiences; they also suggested that the profiles could serve as content for www.careervoyages.gov.
6. Link academic and workforce board resources to address	This solution calls for an analysis of existing federal, state and local resources, identifying key partners, developing materials such as case studies, and distributing the materials and messages through channels such as mailings, forums, and seminars. The barriers include Workforce Investment Act policy, a number of legacy policies, higher education policies at the

the image challenge and integrate resources to make an impact.	state level, and privacy issues. Integration is an important concept that deserves further consideration. Linking resources will require a vehicle. Specific information on partnerships could help bolster sustainability approaches. It could also be a strategic element of communications efforts.

Challenge 3 **Pipeline**	**Description** Pipeline issues are related to recruitment, retention and professional development strategies, initiatives and tools to increase and go outside traditional geospatial technology labor pools.

Issues & Observations

Geospatial technology stakleholders reported that pipeline issues present significant challenges. Insufficient communication on career opportunities, especially to components of the publicly funded workforce investment system, curriculum development and training needs at all levels, security clearance issues and diversity issues are among the barriers to developing an adequate pipeline of geospatial workers. The stakeholders also pointed out the imperative to develop non-tradditional labor pools if they intend to keep up with the sector's projected growth. In their estimation, the pipeline of workers for their industry will need to include: foreign students, dislocated workers, retirees, minority populations, transitioning veterans, youth, college students, incumbent workers, IT workers with transitional skills, and workforce re-entries. Stakeholders focused on two education vehicles to improve the pipeline:

9. **K-12 education system** – Executives reported that "education is becoming very test-oriented and as a result, the practical aspects of the industry are being lost on young people." They believe this is adversely affecting many science and technology industries and technical career opportunities. Focusing young people on science, technology, engineering and mathematics (STEM) related disciplines and careers is a key component of building a pipeline of workers. Providing K-12 systems with the tools, resources and comfort level to promote technical careers, such as geospatial, is an important first step.
10. **Community colleges and technical schools** – The U.S. Department of Education Office of Vocational and Adult Education reports that outsourced training expenditures for U.S. companies nearly doubled between 1994 and 2000, growing from $9.9 billion to $19.3 billion annually. This demand has created a market for contract training and curriculum development that community colleges are highly qualified to meet.[29] The report also identified a number of key characteristics of market responsive community colleges:

[29] U.S. Department of Education, Office of Vocational and Adult Education. "Documented Characteristics of Labor Market-Responsive Community Colleges and a Review of Supporting Literature." 2003.

○ Ladership committed to the goal of making the college market-responsive; ○ Internal response mechanisms; ○ Business and other partnerships; and, ○ Connection to the local economy.	
Solutions: Pipeline	Pipeline workgroup participants identified 47 possible solutions and developed solution matrices focusing on three priority categories: 1) recruitment, 2) retention, and 3) professional development.
Recruitment Solutions	
1. Employers and job seekers could benefit from better definitions of the geospatial industry; for example, better metrics on the industry sectors, specific employment tends, and needs.	This solution requires a survey of industry need, profiles of job opportunities, and methods for measuring the awareness of job opportunities in both the private and public sectors. Human resources and funding for dissemination are also needed. NWDETI stakeholders reported that Mississippi State University is already updating its 1998 Industry Survey, which could become a useful resource. Stakeholders noted several "image and outreach" solutions that could be linked with this kind of information gathering exercise.
2. Start with middle and high school students to provide geospatial experience by incorporating the technology in science and social science work. Train teachers to use it and teach with it. Get software in labs for student use.	This solution would deliver geospatial technologies, curriculum and activities for teachers. The barriers include support from the administration. Development should consider a dual-language component. The State of Mississippi has developed a program that could serve as a model. NASA also provides substantial resources and access for teachers that should be leveraged and not duplicated. Participants pointed out that more detail is needed on how the public workforce investment system would fit in.
3. Target outreach to professional societies	This solution requires targeting geospatial societies/associations and partnering with their outreach components to reach user and applications societies and associations. The Geospatial Technology Solutions Forum participants are the primary stakeholders.

involved in geospatial or related work (civil engineering, geography, geology, urban planning).	Barriers include coordination and money for development. This approach could be part of a larger national campaign or communications strategy.
4. **Conduct a media recruiting campaign using TV, radio, and magazine advertising to provide more exposure to the technology, increasing public awareness.**	This solution calls for a national campaign that does not limit audiences and focuses on a concise message through diverse media. Barriers include lack of funding and fragmentation of societies. Several of the solutions already discussed could be rolled up in such a campaign, including communications strategy, linking academia and workforce boards, and outreach to professional societies. **This is one of the three priorities selected by the pipeline workgroup**.
5. **Institute a job training/transition program for veterans, retirees, and government employees. (E.g. troops to teachers. Identify military skills that translate to civilian skills. Include materials to describe characteristics and companies that are involved.)**	This would require development of a web portal with occupational profiles, jobs, additional education, and credentials needed. Money and support could be barriers to implementation. USM has developed the Geospatial Technology Online Assessment Tool, which provides key information on competencies needed and links to two and four year programs available nationwide. Career profiles were included as one of the solutions under image and outreach and could be included as part of content development for www.careervoyages.gov. One option could be to include this kind information and access as part of Career Voyages content development, including access to the USM tool.
Retention Solutions	
6. **Involve employees in decision making and project selection when feasible.**	This solution calls for the general establishment of a team building environment, including a clear definition of goals, employee empowerment, management support and diverse products and services within the company. Labor and management issues may be a barrier. Many organizations have undertaken similar approaches to team building and the work environment, helping to retain employees through buy-in and involvement.
7. **Transition training for**	Necessary elements include: local access training centers (community colleges), an understanding of geospatial needs and applications, and committed employers. The barriers

"obsolete" skill sets and dislocated workers.	include the worker's age, union issues, and company commitment. Incumbent and transitioning worker training can allow the industry and user organizations to benefit from the experience and wisdom in decision making of these non-traditional labor pools.
8. Development of agency/industry exchange programs to develop an understanding among diverse groups.	Requirements include: willing agencies, academia, and industry, as well as job shadowing rotations, development or adoption of other models, flexibility in tailoring to individual needs and conflict of interest or non-disclosure agreements. Labor laws, clearance issues, individual agency/industry policies, and non-disclosure were identified as potential barriers. This could be an innovative approach to gaining on-the-job learning experiences. Stakeholders suggested that mentorship and cooperatives should be considered as elements of this solution.
9. Develop industry-specific focused survey tools to share salary benefits and best practices.	This solution would require standard job titles, an instrument sensitive to business size across industry and regionally sensitive data, best practices, and compensation comparisons within related technologies. Privacy disclosure was identified as a barrier. Other data related issues such as compilation, validation, distribution and maintenance were mentioned. Salary information comparison and best practice sharing are among the top issues identified by stakeholders for helping to recruit and retain employees. They believe the entire sector would benefit from some form of this solution in combination with other data collection efforts. **This solution was labeled a priority by workgroup participants.**
10. Develop a national system of certification, including stratification, to provide increased compensation and mobility across industries and disciplines.	This solution calls for universal recognition across political boundaries and industries, certification at a number of levels of expertise, well-defined competency levels and testing, and an accreditation process for certification programs. The barriers include accreditation acceptance and industry adoption. Stakeholders noted that URISA, ASPRS and the Board of Registration for Professional Engineers and Land Surveyors have been providing certificate programs within the last ten years. The URISA Certification Committee was established in 1998 to develop professional certification in each of 23 discipline areas. None is universally recognized or as flexible as required for the diverse geospatial technology skills sets that stakeholders identified. The group reported that the SpaceTEC coalition has developed and is beginning implementation of a national aerospace technician certification.

	The Geospatial Technology Apprenticeship Program (GTAP) apprenticeship certification process now being developed and validated by ETA is intended to be a national, portable certification. As part of this project, GTAP is utilizing the Spatial Technology and Remote Sensing or STARS curriculum and certification process, which has been deployed in several regions. Reconciling assorted certifications and developing a standardized, universal model certification would be valuable. This solution could be part of larger capacity building efforts and was **identified as an overall priority by the group**.
Professional Development	
11. Encourage industry focused educational institutions providing convenient on-site or on-line, affordable, customized training to geospatial employees to prepare for the next generation of skills.	This solution requires community colleges or other training deliverers, and financial resources for course development. Barriers include lack of recognized certification, reluctance of community colleges and universities, lack of state funds for community colleges to develop new training programs, reluctance of industry to give release time for training. Stakeholders suggested this solution as a delivery mechanism for the national certification discussed elsewhere. On-line access could be a vehicle to involve one-stop centers and workforce investment boards. This solution highlights the need for incumbent worker training .
12. Provide incentives, grants, and tax breaks for innovative applications of geospatial technology. Support partnerships linking mature and start-up programs.	This solution calls for a national association to lobby for these incentives. Stakeholders noted that ETA could transmit this suggestion to the Office of Management and Budget.
13. Establish a centralized certification body, process and nomenclature that provides for universal recognition.	This solution requires a national body to verify competencies that are certified, standardized, portable and transferable. A standard definition of terms would be developed around this industry. The barrier is the lack of a national body. “Centralized” and “easy to understand” should characterize a national certification; agreement on a common language would aid certification and professional development strategies.
14.	Requirements include: identifying applicable competencies and mastery levels,

Develop a training program for geospatial technicians in higher-level skills in the geography and spatial analysis, physics, remote sensing, and math disciplines.	developing alliances between companies and educational organizations (community colleges), convenience, and affordability. Barriers include lack of industry awareness and compliance with military training requirements. This is another solution highlighting incumbent worker training.
15. **Work with local colleges to establish degree and certification programs in line with current needs. Develop tuition incentives.**	This solution calls for developing standardized, affordable curriculum to tech critical competencies. Colleges could create a geospatial technology department and businesses could lend talent to teach the technology. Barriers include agreement on a curriculum, reluctance of universities to accommodate and adapt, and employers' reluctance to allocate education time. This could be an opportunity to share resources and promote public/private partnerships.

Section IV: Implementation of Solutions and Conclusion

The Employment and Training Administration (ETA) supports comprehensive business, education and workforce development partnerships to develop innovative approaches and replicate models that effectively serve the workforce needs of business while helping workers find good jobs with good pay and promising careers. Grants awarded under the High Growth Job Training Initiative implement unique and innovative, industry-driven skills training, certification and career ladder development programs that support identified geospatial technology sector workforce and economic development needs.

Based on the challenges identified by the geospatial technology sector and highlighted in this report, ETA has made a series of investments totaling more than $6.4 million to partnerships among business, community colleges, the public workforce investment system and other partners to address the needs of the geospatial technology sector. Grantees must account for and leverage key public workforce investment system capabilities. Solutions are national, state and local in scope and address key geospatial technology sector challenges in unique and innovative ways. The following highlight ETA's investments to address these challenges. Additional information is posted at: http://www.doleta.gov/brg.

Redefining and Communicating Geospatial Industry Workforce Demand – Geospatial Information Technology Association (GITA)
This $695,362 grant will help to broadly develop and disseminate authoritative information regarding the geospatial technology industry's occupational and skills definitions and data. The challenge addressed in this project is the need for a consensus industry definition or method for collecting economic and workforce data to help promote career opportunities and future worker needs. The project will include outreach to the public to improve the geospatial technology sector's image and to improve basic public spatial literacy. GITA and its partners will provide a total match of $670,927 to supplement the ETA investment.

Geo 21 Project – Kidz Online and the NASA Center for Distance Learning (CDL)
The Geo 21 project, a $1,000,000 grant, is a comprehensive awareness and image-building effort targeting youth and adult learners. Nortel will deliver learning resources, including video programming and live web casts, provide professional development services, and integrate geospatial concepts into existing programming and ETA's Career Voyages website. The workforce challenges addressed include lack of knowledge about possibilities of employment either in the geospatial technology industry or in associated user sectors. Insufficient communication about career opportunities has been among the key barriers to developing an adequate pipeline of geospatial workers. NASA's Center for Distance Learning at Langley Research Center is a primary partner on this project. Nortel will provide a total match of $1,002,055 to supplement the ETA investment.

Geospatial Imagery Analysis and Practical Applications – William F. Goodling Advanced Skills Center (ASC)
This $990,125 project will establish a geospatial technology education training center to support user-focused applications. ASC will develop a certificate program in imagery analysis in private and municipal applications with 2+2+2 articulation agreements with high schools, community colleges, and universities to produce imagery analysis technicians. These 2+2+2 articulation agreements provide students and/or workers with career and education advancement tracks, enabled by linked curriculum and levels of education, training and certifications at the high school, community college and university levels. The workforce challenges addressed by this project include the need for imagery analysis technician and geospatial technology user certifications. The ASC and its partners will provide a total match of $495,000 to supplement the ETA investment.

The Geospatial Business Hub Project: Preparing the Nation's Geospatial Workforce – The Institute for GIS Studies and Central Piedmont Community College (IGISS)
This grant of $2,000,000 will produce an industry-led, apprenticeship-based advancement ladder for specialty certificates and degrees in high-demand geospatial technical applications. The key workforce challenges addressed include the need for career ladder and education advancement approaches and standard certifications for geospatial technology applications communities in land records management and utilities. IGISS and its partners will provide a total match of $4,387,327 to supplement the ETA investment.

A Model for Connecting the Geospatial Technology Industry to Community College Workforce Development: Geospatial User Needs Assessments – Rancho Santiago Community College District (RSCCD)
This $187,939 initiative will create, test and deliver a replicable model whereby community colleges, in cooperation with local businesses, governments, trade associations and workforce investment agencies can assess local geospatial workforce needs and use the findings to adapt existing curriculum and career ladder systems for local geospatial user industries. RSCCD and its partners will assess the needs for geospatial skills in the natural resources, construction, manufacturing, trade/transportation and other key local geospatial technology user communities. Workforce challenges addressed include the need to evaluate what skills and competencies are required by geospatial technology user sectors. RSCCD and its partners will provide a total match of $56,684 to supplement the ETA investment.

Conclusion

By every estimate, the geospatial sector will continue to grow, spurred by the acceleration of technology innovation and the need for location-based data of all kinds. Users of geospatial data and information will continue to increase in diverse industries, from agriculture and banking to transportation.

Building on NASA's National Workforce Education and Training Initiative, the High Growth Job Training Initiative has engaged a broad range of geospatial technology stakeholders to better understand the workforce challenges of this emerging sector. ETA has made key investments in several innovative partnerships intended to address these challenges. These partnerships will demonstrate how the public workforce investment system, by attending carefully to the emergent and changing needs of business and industry, can aid workers in securing good jobs with good wages and promising career pathways.

These investments and partnerships are just the beginning of the implementation process. ETA will continue to work with the geospatial technology sector to gather and disseminate best practices and lessons learned from its current investments and other ongoing education and training activities nationwide. ETA will also work with the grantees to ensure that the projects are sustainable and can be appropriately replicated in other areas of the country and within other high growth/high demand sectors of the American economy.

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Appendix A

A Complete List of HGJTI Industries

1. Advanced Manufacturing
2. Aerospace
3. Automotive Services
4. Biotechnology
5. Construction
6. Energy
7. Financial Services
8. Geospatial Technology
9. Health Services
10. Homeland Security
11. Hospitality
12. Information Technology
13. Retail Trade
14. Transportation

Appendix B

Academia Sector

Last Name	First Name	Organization
Annulis	Heather	The University of Southern Mississippi
Arnold	Patricia	The Space Foundation
Bednarz	Sarah Witham	Texas A&M University, Department of Geography
Bergerud	Marly	Workforce and Economic Development, De Anza College
Brey	James	University of Wisconsin Fox Valley
Brower	Robert	The Institute for the Applications of Geospatial Technology at Cayuga Community College
Campbell	Shannon	Jones County Junior College
Carr	Jon	University of Southern Mississippi, WLPC
Chase	Brian	The Space Foundation
Conner	Bill	The Institute for the Applications of Geospatial Technology at Cayuga Community College
Cunniff	Patricia	Space Tech
Dannreuther	Maggie	Mississippi State University
Davis	Robert	California Space Authority, Inc.
Dozier	Matt	East Initiative
Eisenhart	Steve	The Space Foundation
Finch	Lorna	St. Louis Community College
Flinton	Michael	Spatial Technologies Information Center at Fulton Montgomery Community College
Foil	Jennifer	The University of Southern Mississippi
Foster	Jamie	California Space Authority, Inc.
Gaudet	Cyndi	University of Southern Mississippi
George	Robert	Woodside High School, NASA Center for Distance Learning
Gershwin	Mary	Colorado Community College
Hagelston	Janeen	The University of Southern Mississippi
Hawkins	Annette	USM - Stennis
Kent	Norma	American Association of Community Colleges
McKenney	James	American Association of Community Colleges
Mitchell	Brian	The University of Southern Mississippi
Mohling	Wendell	National Science Teachers Association
Powe	David	Ole Miss/USM
Pulham	Elliott	The Space Foundation

Appendix B

Academia Sector

Last Name	First Name	Organization
Richardson	Douglas	Association of American Geographers
Ritchie	Liesel	Mississippi State University
Shao	Guofan	Purdue University/ SAF
Sims	Linda (Cherry)	Mississippi State University
Slark	Julie	Rancho Santiago Community College District
Sumner	Candace	JCJC
Thomas	Chuck	Advanced Skill Center
Williams	Heather	The University of Southern Mississippi
Zeiss	Chuck	Central Piedmont

Appendix B

Government Sector

Last Name	First Name	Organization
Allison	Sue	U.S. Department of Labor, ETA, Business Relations Group
Blake-Coleman	Wendy	U.S. Environmental Protection Agency
Bogosian	Joseph	U.S. Department of Commerce
Brauer	Douglas	National Oceanic and Atmospheric Administration/NESDIS
Burgess	William	NSGIC
Carpino	Christine	NOAA
Cast	Cast	U.S. Department of Homeland Security
Castro	Lorraine	National Imagery and Mapping Agency
Clapper	James	National Imagery and Mapping Agency (NIMA)
Colton	Marie	National Oceanic and Atmospheric Administration
Crowe	John	U.S. Department of Homeland Security
Dann	Liz	National Imagery and Mapping Agency
Deguara	Juan	National Imagery and Mapping Agency
Echarvarria	Fernando	U.S. Department of State
Fordyce	William	U.S. Geological Survey
Gilbert	Gay	U.S. Department of Labor, ETA, Business Relations Group
Goodson	Dennis	US Department of Labor - Apprenticeship
Groat	Charles G.	USGS
Hall	Warren	NOAA, Satellite and Information Services
Hissong	Frank	Bureau of Land Management
Kiernan	Allison	Federal Geographic Data Committee
Landvoight	Arnold	National Security Agency
Lautenbacher	Conrad	NOAA
McAlister	Sean	International Trade Administration, U.S. Department of Commerce
Osborn	Stephanie	NACo
Parker	Randy	U.S. Department of Labor
Perry	Joe	NIMA/NGA
Sharp	Kirk	NASA Earth Science Applications
Sherwood	Harla	NASA Center for Distance Learning
Soule	Helen	U.S. Department of Education
Trobia	Gene	National States Geographic Information Council (NSGIC)

Appendix B

Government Sector

Last Name	First Name	Organization
Wells	Damon	U.S. Department of State
Wells	Kim	U.S. Department of Commerce
Whitman	Christine	U.S. Environmental Protection Agency
Withee	Greg	National Oceanic and Atmospheric Administration
Woodridge	Charles	National Oceanic and Atmospheric Administration, Satellite and Information Services
Zuidema	Byron	U.S. Department of Labor, ATELS

Appendix B

Industry Sector

Last Name	First Name	Organization
Ancell	Clay	Earth Data
Arabadjs	Liz	Highland Geographic
Baker	Kelle	Harris Corporation
Barber	Andrew	AIA
Bosak	Betsy	Northrop Grumman Space Technology
Bush	Wes	Northrop Grumman
Campbell	Joel	ESRI
Chamberlain	Steve	Integral Systems
Cooke	Richard	Research Systems, Inc.
Corle	Fred	Spatial Technologies Industry Association
Dailey	Andrew	ESRI
Dalal	Robert	Space Imaging
Dalbello	Richard	Satellite Industry Association
Dangermond	Jack	ESRI
Davis	Robert	California Space Authority, Inc.
Dold	Sharon	Raytheon
Dougherty	Andrew	3001, Inc.
Douglass	John	Aerospace Industries Association
Eggen	Kim	Resource 21
Faintich	Marshall	Sensor Systems, Inc.
Filomeo	David	Lockheed Martin
Fisher	Norman	Raytheon Intelligence and Information Group
Foster	Jamie	California Space Authority, Inc.
Fry	Kristin	Booz Allen Hamilton
Galyean	Angela	Orbimage
Giordano	Sherry Thompson	Questerra, LLC
Graziani	Paul	Analytical Graphics, Inc.
Huddleston	Tim	Aerospace States Association
Huether	Mike	Kodak
Johnson	Ann	ESRI
Johnson	James	United Space Alliance
Karmazin	Greg	STIA
Keating	Terrence J.	ASPRS
Keebaugh	Mike	Raytheon Company
Klimkiewicz	Karen	Space Imaging
Kludt	Richard	Lockheed Martin
Lee	Angela	ESRI
Leonard	Vic	Resource 21, LLC
Levy	Karen	GITA
Logan	Bryan	EarthData Holdings, Inc.
Logsdon	David	Aerospace Industries Association
Mahone	Bruce	Aerospace Industries Association
Marsh	G. Thomas	Lockheed Martin
Mateer	Sara	Swales Aerospace

Appendix B

Industry Sector

Last Name	First Name	Organization
Milovich	Tim	Questerra, LLC
Moeller	John	Northrop Grumman
Mondello	Charles	ASPRS
Moraco	Tony	Boeing Autometric
Morrish	Brenda	Harris Corporation
Mott	Michael	Boeing
O'Connell	Matthew	Orbimage
Pajer	Pam	Research Systems, Inc.
Petersen	Kristi	Raytheon
Porter	Joel	Lockheed Martin
Prentice	Tameiko	ESRI
Roberts	Chuck	ESRI
Robinson	Brad	University of Southern Mississippi
Rodgaard	John	Boeing Autometric
Satterlee	Herbert	DigitalGlobe
Schmidt	Michael	Orbimage
Skelnik	Richard	General Dynamics
Soltis	Robert	SAIC
Sonnen	David	ISSI
Speckman	Toya	Ball Aerospace & Technologies Corp.
Stahl	Gene	BAESystems
Taylor	David	Ball Aerospace & Tech.
Thomas	Karen	Raytheon
Tietz	Lisa	Kodak
Velte	Lisa	Analytical Graphics Inc.
Vera	Glenn	Florida Space Authority
Voccola	Harry	Navigation Technologies
Wald	Bruce	Eastman Kodak

Appendix B

Users Sector

Last Name	First Name	Organization
Ancel	Susan	EPCOR
Asbury	Stewart	Byers Engineering Company - SpatialAge Solutions Division
Brower	Robert	The Institute for the Applications of Geospatial Technology at Cayuga Community College
Clark	Terry	Society of American Foresters
Conner	Bill	The Institute for the Applications of Geospatial Technology at Cayuga Community College
DiSera	Dave	EMA, Inc.
Duffy	Greg	Woodfield Consulting
Gomez	J. Peter	Xcel Energy
Jarreau	Bert	National Association of Counties
Jones	Brent	Energy & Telecom Services - James W. Seawall Company
Kumar-Rubock	Wilma	Washington Gas
Kuykendall	Richard	GITA
Lees	Joseph	Homeland Protection Institute
Levy	Karen	GITA
Lombard	Martha	URISA
Lopez	Xavier	Oracle Corporation
Richardson	Douglas	Association of American Geographers
Samborski	Robert	GITA
Schell	David	Open GIS Consortium
Soiland	Lisa	American Management Systems
Tomlin	Donald	Florida Power & Light Company
Wollack	Leslie	National States Geographic Information Council
		American Gas Association
		American Public Power Association
		American Public Works Association
		American Planning Association
		American Water Works Association
		Edison Electric Institute
		International City/County Management Association
		National Association of Counties

Appendix B

Workforce Sector

Last Name	First Name	Organization
Cashen	Kate	National Association of State Workforce Agencies
Cassidy	Patrick	National Association of Workforce Board
Collins	Walter	ATELS
Powers	Stephanie	National Association of Workforce Board

Appendix C

High Growth Job Training Initiative Matrix

Participants / Contributors:

Angela Lee, Marshall Faintich, Gene Stahl

Issue: Skills, Competencies & Training: Mapping

Solution: Develop skill centers; community workshops and training programs for decision makers and managers

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Skills included: GIS; remote sensing; GPS - Stakeholder groups who help define what skills are delivered - Resource gap analysis - Decide where the training will take place; is it a physical site or is it virtual? - Customizable training for walk-in clients; assess skills and what additional skills are needed - Benchmark current use and replicate - Must stay connected to geospatial industry to stay up to date - Basic spatial train - National in organizational scope - Instructional capacity of centers should be WAN enabled	- Department of Homeland Security - NASA - Public Sector Employees at all levels of government - Software providers - Software developers - Chamber of Commerce - Community - Workforce Investment Boards - Economic Development Authorities - Northeast Affiliates	- Municipal representatives - Land asset management reps - Environmental trainers - User community – One ETA manager and a handful of outreach (5-10) people - NACo in kind political - NSGIC - Seed money to get from U.S. Department of Commerce - One stop access – hire trainers - Regional facilitator	- Top down policies	- Need to coordinate - Need better bottom-up decision making

Appendix D

Issue: Skills, Competencies & Training: Mapping				
Solution: Develop skill centers; community workshops and training programs for decision makers and managers				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Able to support evolution of Geospatial tech. in your business - Qualified instruction				

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Angela Lee, Marshall Faintich, Gene Stahl

Issue: Skills, Competencies & Training: Mapping				
Solution: Host community forums for sharing existing geospatial information				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Know domain and how to do it as opposed to data - Awareness building - Training for existing jobs - Once meetings are in place, share best practices and knowledge - Distance learning	- User community - Chamber - Economic development authorities - Local government	- Web site – categorize web site - Database administrator – in kind	- Copy writes on information	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Angela Lee, Marshall Faintich, Gene Stahl

Issue: Skills, Competencies & Training: Mapping				
Solution: Define business functions and look at where those functions are performed				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Identify business functions - Administrative information decision - product delivery and production - outreach to business - community/user community - cross walk re geospatial competency model to identify - common tasks, how much is done in specific domain - outreach to content analysis, job parts - identify key sections see what skills practices	- STIA/industry association - Specific industry associations - Chambers of Commerce - Economic development authorities	- U.S. Department of Labor/Federal sponsored project - U.S. Department of Commerce		- Defense/intelligence community policies - Department of Homeland Security critical infrastructure maintenance

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Mapping

Solution: Create a reference guide to understand (where to find stuff)

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Easily maintained and updated - Easy access – web based XML or better - Linked other sources of information - Other language - Establish criteria for information and timeline - Should be a re geospatial one stop job posting resumes - Links to potential suppliers - Broader information than the One Stop - Standardized Data	- Providers of information and services - Software providers - GIS – hardware suppliers - Users of hardware, software and data - Chamber - Government data providers - NGA, NASA, USGS - Training – GeoWDC	- One manager - Have a server - Outreach staff with sponsorship goals - Borrow computer time	- Information sharing - Finished product - Online tutorial	- Regional approach

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Angela Lee, Marshall Faintich, Gene Stahl

Issue: Skills, Competencies & Training: Mapping

Solution: Identify target industries for training

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Develop criteria – do number 1 first and get feedback and patterns will emerge	- Same as business function			

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Angela Lee, Marshall Faintich, Gene Stahl

Issue: Skills, Competencies & Training: Mapping				
Solution: National strategy for geospatial non-profit				
Critical Attributes (What attributes are needed for success?)	Key Stakeholders (Who are needed for success?)	Resources (Financial, Human, and Technical)	Implementation Barriers	Anything Else???
	- Providers of information and services - Software providers - GIS – hardware suppliers - Users of hardware, software and data - Chamber - Government data providers - NGA, NASA, USGS - Training – GeoWDC			

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Competencies				
Solution: Develop geospatial curriculum in schools				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Work geo skills into existing standards - Qualified trainers	- ALL stakeholders - Curriculum Developers - Super Association - DOL ETA - Teacher College Associations - School Boards			

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Competencies				
Solution: Develop…On-The-Job-Training				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Same as public sector training - Develop OJT curriculum - Develop apprenticeship - Cross disciplinary curriculum	Additional Stakeholders - Business and Industry Stakeholders - Industry Assoc. - Apprenticeship System - Prof. Assoc.	- OJT opportunities that already exist – businesses that offer - Industry assoc. professional assoc. to linking company to company and individual to training - Promote case studies and training opportunities		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Competencies				
Solution: Develop programs specific to GIT competencies into public sector training				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Non-four year programs - Modular training - Appropriate customized application must be - Identify centers for excellence to deliver - Before being trained trainer must understand its applicability and learn it during training	- Consortium - Trainers - Civil Service - Private Trainers - ESRI.; GITA - AAG - Elliott Masie, the Masie Center	- University consortium for geographic information science www.vcgis.org curriculum developed and levels of competency - NCGIA academic consortia. Jr. college curriculum - One-stop career centers		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Competencies				
Solution: #1				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Qualified/certified instruct - Identify existing models deemed successful - Identify the certifying body - Re-introduce SOL in geospatial into educational community - Accessible training - Certified curricula - Need to identify a champion - Institutionalize the process implementation	- Industry - Academia - Federal, State, Local Government - Industry Association	- Successful models - Federal government for data accessibility - Workforce Investment Act dollars - Foundations - Apprenticeship system - O*NET - Curriculum under - Policy to support collaboration across agencies and institutionalize these competitions - On-line training to deploy to industry - SOL to deploy to Educators	- Education re-institute SOL - Cost for accessibility is an issue	- Certifying battle who should spearhead the certifying process

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Deployment				
Solution: Develop competency standards used by GIT integration trainers within target groups				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Certification Standards - Multiple levels of trainers, users, business owners, trainers - Train the trainers				

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Deployment				
Solution: Conduct small business workshops to determine needs/requirements, training based on user needs, nurture potential users				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Qualified trainers - Qualified curriculum - Recognized by community (broad) - A follow up process (implementation/issues/usage) - Performance metrics - Reasonable or low cost	- Chambers of Commerce - SBA - Workforce Investment Boards - Educational Community - Chief Elected Official - Geospatial Technologies Industry	- New money - Knowledge base or users - Software - IT support - Connection or access to real time data from NASA or others - Marketing - Data appropriate for training - Suitable hardware at training site	- WHO	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Deployment				
Solution: Deploy core training in K-12/community college. Deploy specialized training tracks such as business administration, IT, R&D, and/or geospatial solutions.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Qualified trainers - Qualified curriculum - Recognized by broader community - A follow up process (implementation/issue/usage) - Performance Metrics - Teach transferable skills not jobs/occupations - Training should include hands-on field work - Geospatial tech incorporated into existing course work	- States Board of Educations - Departments of Education (State) - National Center for Teacher Education - Geospatial Technology Industry - Chart Committees to focus on academic tracks - State GIS Clearing House	- Professional development - New money - Knowledge base of users - Software - IT support - Data Appropriate - Suitable hardware at training site	- State certification requirements - A new course is a barrier - State mandated credits - Creation of new curriculum and new degree - Gaining security clearance and long delays in process - Conflict of regulations immigration vs. security	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Deployment				
Solution: Create training program that includes classroom and field training (application).				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- People using application in the field - Agreements with existing user community - Classroom and field experience needs to be coordinated - Directed toward real vs. theoretical problems	- State GIS Clearing House - Geospatial Technologies Industry - Workforce Investment Boards - Chamber of Commerce	- Production or worker training others - State Clearing House GIS - New money - Knowledge base of users - Data appropriate for training - Suitable hardware	- Local government to share data (State/Federal) - Privacy Issues - Equipment for field testing/data collection - WIB requirement (local level demand occupation)	- Opportunity to provide community service (class projects) - Where does information go

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Deployment				
Solution: Portal for jobs and education and training programs available				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Widely available - Widely known - Easy to navigate/use - Tied into existing portal systems - Powerful and easy way to add new content - Self Maintaining - Standard format for content	- Geospatial Technologies Industry - Employers - Educators - ISP - DOL	- New money - Evaluation/feedback monitoring and reporting	- WIB requirements - WIA interpretation - Reaching consensus	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Issue: Skills, Competencies & Training: Deployment				
Solution: Establish geospatial coordinator at local one-stops.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Entire Breakout

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Develop a workgroup to develop and validate the conceptual industry model using a consensus approach to define the Geospatial Industry.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Sponsoring organization with interested stakeholder	- Industry representatives	- Human Capitol	- Maybe some organizational issues, U.S. Departments of Labor or Commerce resistance	- Sponsoring organization with interested stakeholder

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Entire Breakout

Issue: Image and Outreach to the Public: Definition and Data; Image				
Solution: Develop a task force/advisory group to "vet" programs and spending.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Clear mandate from the U.S. Department of Labor Secretary - Active group of participants - Input from the industry on the development of U.S. Department of Labor criteria	- U.S. Department of Labor Secretary - Education - Workforce Investment Boards - Trade Associations	- Leadership	- Reauthorization of WIA Policy - Academic Higher Education Policies - No input from industry on criteria	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Andrew Barber, Fred Corel and John Moeller

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Develop a message that demonstrates Geospatial as an enabler of other location applications.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**

- What Geospatial does
- Practical easy to understand by a large part of the population … your average person can do this
	- Industry
	- Academia
	- Potential Geospatial Workforce Prospects
		- Funding for development
		- Funding for dissemination
		- Industry and academia develops message
		- Geospatial disseminate through contractors
		
		- <u>Resources:</u>
		  - Web
		  - Marketing Skills
		  - Career Counselors
			- Budget Constraints	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Andrew Barber, Fred Corel and John Moeller

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Develop an academic and industry communications strategy through the federal, state and local partners identifying what skills are required and map to industry standards

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Build upon competency model of NASA/USM – get broad consensus - Match against NAICS codes - Gap analysis - Current – update yearly - Broad communication from industry on competency model	- University of Southern Mississippi - NASA - State Departments of Labor and Workforce Boards - Industry Associations (STIA, AIA, ASPRS, etc.) - NACO, ICMA - Tribal Associations	- Funding - Communication experts - Industry, academia and non-profit support	- Proprietary data - Lack of consensus on roles	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Andrew Barber, Fred Corel and John Moeller

Issue: Image and Outreach to the Public: Definition and Data; Image				
Solution: Create profiles of Geospatial professionals to make the industry more human.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Profile: Woman carjacked, in trunk, used cell phone, high speed police chase in Virginia (true story) … similar stories out there - Cover heroes who took place in the above using their Geospatial knowledge - Interesting examples of professionals	- Specific people referred to …	- Marketing (paid for by the Geospatial industry and academia - Funding - Career Voyages infrastructure		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Andrew Barber, Fred Corel and John Moeller

Issue: Image and Outreach to the Public: Definition and Data; Image				
Solution: Link the resources of academia and industry and workforce boards to address the image challenge and integrate resources to make an impact.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Getting the right organization involved, while maintaining a manageable size	- Academia - Industry - Workforce Development Organizations	- Committed organizations - Some technical support		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Mary Gershwin, David Powe, Michael Flinton

Issue: Image and Outreach to the Public: Definition and Data; Image				
Solution: Link the resources of academia and industry and workforce boards to address the image challenge and integrate resources to make an impact.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Identify existing resources, i.e., MI Model, Spatial Information Technology Model, state, national local models - Identify needed resources - Identify partners - Replicate MI Model models	- NASA - Workforce Boards - Trade Associations - Community Colleges - Departments of Labor/State Level - State Agencies - 4 Year University Systems	- K – 12 - Community Colleges - 4 Year Universities - Personnel/Human Resources from the above - Technical systems - Capacity of the workforce system	- WIA Policy - (Legacy policies) - Higher Education policy at the state level	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Mary Gershwin, David Powe, Michael Flinton

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Create profiles of Geospatial professionals to make the industry more human.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- ID by existing resources o Sector, competency, SKAs o "sex-up," make appealing o push across different media	- Industry professionals - Federal, state - Professional associations	- Existing studies - Publications - Institutions		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Mary Gershwin, David Powe, Michael Flinton

Issue: Image and Outreach to the Public: Definition and Data; Image				
Solution: Develop an academic and industry communications strategy through the federal, state and local partners identifying what skills are required and map to industry standards				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Understanding of industry requirements - Understanding of education national standards - Continuous process of mapping skills/educational standards	- Education community, federal, state and local - Federal – national and regional - Industry	- Federal - State - Local - Industry - Foundations		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Mary Gershwin, David Powe, Michael Flinton

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Develop an academic and industry communications strategy through the federal, state and local partners identifying what skills are required and map to industry standards

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Open communications - Common language - List of interested stakeholders	- Federal - State - Local – counties - Professionals	- Training Funds - Competent Educators - Translators between business and education	- Academic policies	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Tameiko Prentice, Sherry Giordano, David Filomeo, David Sonnen

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Develop an academic and industry communications strategy through the federal, state and local partners identifying what skills are required and map to industry standards

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Define industry - Define skill sets by sector	- Industry - Academics - Government - Beneficiaries - End-users	- Career Counselors - Government Employment Development Agencies		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Tameiko Prentice, Sherry Giordano, David Filomeo, David Sonnen

Issue: Image and Outreach to the Public: Definition and Data; Image				
Solution: Link the resources of academia and industry and workforce boards to address the image challenge and integrate resources to make an impact.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Organization to bring stakeholders together (non-profit) = association (Geospatial Technologies & Application Associations) GTSS - User scenarios/case studies - Document, publish & communications programs o Mailings o Forums o Seminars	- End Users - Industry representation within sectors - Academic representation - Trade Associations - Unaware beneficiaries	- Membership activities/SIG's - Financial - Marketing - Career Counselors	- Privacy (expert control issues)	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Tameiko Prentice, Sherry Giordano, David Filomeo, David Sonnen

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Create profiles of Geospatial professionals to make industry more human.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Target audience: non-engaged/non-traditional - Generate profiles that help solve a particular problem - Flexibility to address different motivators ($'s, save world, etc.)	- Academia - Industry (participant/purchase) - Counselors (school) – target young children - Government - Unaware beneficiary	- Independent Association (nominations) – "who's who" by category - Marketing - Trade Associations - Career Book o Welfare to Work o K - 12		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Tameiko Prentice, Sherry Giordano, David Filomeo, David Sonnen

Issue: Image and Outreach to the Public: Definition and Data; Image				
Solution: Develop a message that demonstrates Geospatial as an enabler of other location applications.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- ID functionality Geospatial capabilities adds to applications - Develop a method for determining business value of Geospatial Technology within business systems - Develop message: business value of Geospatial technology	- Geospatial industry players - Business manager - Developers - Prospective workforce	- Funding - Trade Groups (Geo T & A, A) - Counselors - Academia		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Julie Slark, Kristi Peterson, Harry Voccola, Pat Cassidy

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Develop a message that demonstrates Geospatial as an enabler of other location applications.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- An ad campaign that demonstrates the value of Geospatial applications in everyday life - Incorporate information about the industry and occupation in school curriculum - Message that appeals to other populations (groups), i.e., retirees, mid-career changers	- Industry - School Network	- Money for advertising and materials and demonstrations	- Education programs are slow to keep up with technology demands	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Julie Slark, Kristi Peterson, Harry Voccola, Pat Cassidy

Issue: Image and Outreach to the Public: Definition and Data; Image

Solution: Develop an academic and industry communications strategy through the federal, state and local partners identifying what skills are required and map to industry standards

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Survey by industry segment the skills continuum needed over time (including existing information) - Define the audience - Create a matrix of messages for audience - Outreach materials targeted to define segments and audiences	- Relevant trade associations - Federal, state, local partners - Academic community - Major industry players - Workforce Boards	- Money, technical, human (committed professionals from each stakeholder) - Outreach material development - Professional marketing group	- Budget/travel restraints at the state/local level - Confidentiality of competitive information	- Security clearances - Nationwide marketing plans are very expensive

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Julie Slark, Kristi Peterson, Harry Voccola, Pat Cassidy

Issue: Image and Outreach to the Public: Definition and Data; Image				
Solution: Create profiles of Geospatial professionals to make industry more human				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Identify key Geospatial occupations – and key attributes (salary, skills, education …) - Identify generic skills for a Geospatial career and sources of training - Certification process	- Industry - Academia	- Funding - Knowledge transfer	- Political priorities for funds	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Julie Slark, Kristi Peterson, Harry Voccola, Pat Cassidy

Issue Image and Outreach to the Public: Definition and Data; Image				
Solution: Link the resources of academia and industry and workforce boards to address the image challenge and integrate resources to make an impact.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- See "Develop an academic and industry communications strategy"				

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Sharon Dold, Carolyn Teich, Lisa Velte, Tony Zeiss

Issue: Pipeline: Development

Solution: Industry focused educational institutions providing convenient on-site or on-line, affordable, customized training to G.S. employees to propose items for the next generation of skills.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Community Colleges & other deliverers need financial resources to develop and implement the training courses - Education deliverers must provide customized, on-site, on-line training -	- Community Colleges & others (Federal, State, local government, geospatial employees) - Education lenders - Education Faculty - Industry Supervisors	- Federal, State, Local Government - Geospatial Employers - Loaned Executives to Colleges from Geospatial Industry - Funds & Identification of Curriculum & Equipment - National Association Funds & Content Expertise	- No national association to bless standardization - Lack of recognized certifications - Reluctance of community colleges & universities to be responsive to industry needs - No state funds for community colleges to develop new training programs - Reluctance of industry to give release time or training incentives - MOS Training must be compatible to these certifications	- Encourage on-site "coaches"

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Sharon Dold, Carolyn Teich, Lisa Velte, Tony Zeiss

Issue: Pipeline: Development

Solution: **"**Incentives" grants and tax breaks for new/innovative applications of GIS/Geospatial technology. Partnerships linking mature Geospatial programs with new/start-up programs.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- National Association to lobby for these incentives	- Business - Military - Universities	- Business Research Groups - University Research - Military Technology - Federal/State/Local Government	- Need the National Association	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Sharon Dold, Carolyn Teich, Lisa Velte, Tony Zeiss

Issue: Pipeline: Development				
Solution: Higher level training program for geospatial technicians to gain higher level skills in geography and spatial analysis, physics, remote sensing, math, etc. training discipline areas.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Identify applicable competencies and mastery levels - Develop alliances between companies and institutes of higher learning (i.e., community colleges) - Convenient delivery and affordability	- Business Leader - Educational Institutions - Government Agencies involved in Geospatial	- Industry Funds - Personal Funds - Mentoring - Industry based on-site coaching	- Industry not aware this is available - Military (MOS) training needs to come into compliance	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Sharon Dold, Carolyn Teich, Lisa Velte, Tony Zeiss

Issue: Pipeline: Development				
Solution: Higher level training program for geospatial technicians to gain higher level skills in geography and spatial analysis, physics, remote sensing, math, etc. training discipline areas.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Identify applicable competencies and mastery levels - Develop alliances between companies and institutes of higher learning (i.e., community colleges) - Convenient delivery and affordability	- Business Leader - Educational Institutions - Government Agencies involved in Geospatial	- Industry Funds - Personal Funds - Mentoring - Industry based on-site coaching	- Industry not aware this is available - Military (MOS) training needs to come into compliance	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Sharon Dold, Carolyn Teich, Lisa Velte, Tony Zeiss

Issue: Pipeline: Development

Solution: Work with local colleges for appropriate degrees and certification programs in line with current needs/ develop tuition incentives (time off) for employees to obtain specialized degrees & certificates.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Identify competencies and mastery levels - Develop curriculum that is standardized and portable that fits competencies - Convenient delivery - Affordable - Identify grant/bonus programs for completing program for company and individuals	- Government agencies providing grant money - Business Leaders - Education Institutions - Government Agencies involved in Geospatial - Geospatial Association *where they exist - Employees themselves *Needs to exist	- Federal/State/Local Financing - Colleges to carve out Geospatial department - Technology loans/grants from industry - Business lends talent to teach technology	- If coordinating groups can't agree on the curriculum - No Geospatial Assoc. - Reluctance of Universities to accommodate & adapt - Companies reluctant to carve out time for education - Military (MOS) training needs to come into compliance	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Retention

Solution: Involve employees in decision making & project selection whenever possible/feasible.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Clear Definition of Goals - Employee Empowerment - Management Support - Team Building - Sufficiently Diverse Products/Services within the Company	- Management - Employees	- Models from other industries are available	- Labor –Management Issues May Pose Problems	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Retention

Solution: Transition training for "obsolete" skill sets/dislocated workers.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Local Access Training Center (i.e., Community Colleges) - Identify Geospatial needs and use - Committed Employer (not to outsource)	- Employees - Employers	- U.S. Department of Labor Incumbent Worker Training - Local Funds	- Worker's Age - Union Issues - Company Commitment	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Retention

Solution: Development agency/industry exchange programs to develop understanding between/among diverse groups.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Willing/amenable Agencies - Willing/amenable Academia - Willing/amenable Industry Site - Job Shadowing/Rotations - Development or adoption of other models - Flexibility in tailoring to individual needs & availability/expertise - Conflict of Interest/Nondisclosure	- Employers/Faculty Employers	- Programs - Models within other industry sectors - Industry/Agency Funds - Minimal Financial Resources required	- Labor Laws - Clearance Issues Individual - Agency/Industry Policies - Non Disclosure	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Retention

Solution: Develop industry specific (focused) survey tools to share salary benefits & best practices.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Standard Job Titles - Instrument sensitive to business sizes across industry, and regionally sensitive data - Captures Best Practices - Compensation Comparisons with in and also to related technologies - Focus on Geospatial workers, not those who only use the tool on occasion	- Employees - Employers - Potential Students - National Organizations/Professionals - Human Resources - Industry Analysts - Consultants - All/Everyone - Guidance Counselors	- National Professional Organizations - Employers - Human Resources - Consultants - Industry Analysts - DOL	- Privacy Disclosure	- Who Compiles? - How Compiled? - How Validated? - How Distributed? - Must be Maintained & Updated Periodically

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Retention

Solution: Develop a national system for certification. A stratification providing increased compensation, provide mobility across industries, and specific discipline/industries applications.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Universal recognition across political boundaries - Universal recognition across industries - Certification in a number of levels of expertise - Well defined competency level or testing - Accreditation process for certification programs	- Students - Employers - Training Providers - Higher Education - Training Institutes - Professional Associations	- Professional Associations - Community Based Training Grants - Industry Technical Expertise	- Acceptance of Accreditation - Industry Adoption	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Retention

Solution: Centralized, easy to understand certification/credentialing body and process that provides for universal recognition.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Local Access Training Center (i.e. Community Colleges) - Identify Geospatial needs and use - Committed Employer (not to outsource)	- Employees - Employers	- DOL Incumbent Worker Training - Local Funds	- Worker's Age - Union Issues - Company Commitment	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Juan Deguara, Joe Perry, Chuck Roberts, Helen Soule', Lorna Finch, Mike Huether, Harla Sherwood, Jim Brey

Issue: Pipeline: Recruitment

Solution: Employers and job seekers could benefit from better definitions of the Geospatial industry for example better metrics on the industry sectors. Specific employment trends and needs.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Develop industry survey of workforce needs, profiles, job opportunities with measures for awareness building - What part is public sector, private sector?	- DOL coordinated input from all sectors - (Counselors, career advisors, etc.)	- Human - Dissemination ($)		

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Recruitment

Solution: Start with middle and high school students experience how cool this stuff is by incorporating it in school science and social science work. Train teachers to use it and teach with it. Get software in labs so students can use it.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Introduce educators (tweak interest) to Geospatial Technologies -basic information -definitions -lab activities -career - Point teachers to stand alone programs - Develop new programs if needed	- Educators - Curriculum Specialist - State Department of Education - Vendors	- Development of comprehensive program that aligns with standards	- Support from administration	- Dual language component (English & Spanish)

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Recruitment				
Solution: Outreach to professional societies associated to Geospatial or related work civil engineer, geography, geology, urban planning, etc.				
Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Target Geospatial society/associations & partner in their outreach components	- Forum Members	- Releases - Brochures - Image - Video - Displays	- Coordination - Money for Development	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Recruitment

Solution: Media campaign to recruit through (TV, Radio, Magazine, Ads) to provide more exposure to the technology so people are more aware.

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- Target Geospatial *Campaign national in scope - Target: broad spectrum, no limit to audience - Concise message - TV, radio, web, magazine	- Industry - Government (Local – Federal)	- Industry ad & recruitment budgets - Society/Industry Organization to spearhead with input from Dept. of Labor	- Money - Fragmentation of societies	

Appendix D

High Growth Job Training Initiative Matrix

Participants / Contributors:

Randy Parker, Bill Cannon, Liz Arabadjis, Tony Moraco

Issue: Pipeline: Recruitment

Solution: Institute a job training/transition program for vets, retirees, government employees, etc. (example: troops to teachers. Identify military skills that translate to civilian skills. Also include materials to describe characteristics and companies that are involved.).

Critical Attributes (What attributes are needed for success?)	**Key Stakeholders** (Who are needed for success?)	**Resources** (Financial, Human, and Technical)	**Implementation Barriers**	**Anything Else???**
- *Portal (web) with occupational profiles, jobs, additional education, credentials needed	- U.S. Department of Labor - Industry - Society - Educational Insight - Department of Defense - Congress - Office of Management and Budget (OMB)	- Government (DOL) provided website and support	- Money, support?	

Appendix D

All Solutions

Skills, Competencies and Training Break-out

Subcategory Competencies

1. Look at successful models in other areas for application and develop certifications for user community to demonstrate geo competency, i.e., pyramid taking geospatial business competency model into user community
2. Develop programs specific to GIT competencies into public sector training
3. Develop programs specific to OJT, employed worker training, and apprenticeship with business and industry
4. Develop geospatial curriculum in schools
5. Develop competency standards used by GIT integration trainers within target groups

Subcategory Mapping

6. Develop skills centers, community workshops, and training programs for decision-makers and mgrs.
7. Define business functions and look at where those functions are performed
8. Host community forums for sharing existing geospatial information
9. Create a reference guide to understand where needs, applications, and programs are
10. Identify target industries desiring targeted training

Subcategory Deployment

11. Conduct small business workshops to determine needs/requirements and offer training based on user needs. Nurture relationships with Chambers of Commerce/ED/Econ. Dev./WIBs sharing and leveraging resources
12. Deploy core geo-literacy training in K-12 and community colleges (students and teachers). Deploy career oriented specialized training tracks such as business admin, IT, R&D, Geospatial Solutions
13. Create training programs that include classroom and field training (application)
14. Portal for jobs linked to ED and Training programs available
15. Establish geospatial coordinated at local one-stops

Subcategory Competencies

16. Develop geospatial curriculum in schools
17. Develop programs specific to GIT competencies into public sector training
18. Look at successful models in other areas for application, i.e., pyramid taking geospatial business competency model into user community and develop certifications for user community to demonstrate geo competency
19. Develop programs specific to OJT and employed worker training and Apprenticeship with business and industry
20. Utilize 2+2+2 programs with opportunities to opt out to employment
21. Develop industry consensus on job definitions DACUM process (Assoc with the government agency partnership – consensus direction)

22. Geospatial hierarchy on Public Sector (between departments)
23. Develop competency standards used by GIT integration teams with target groups
24. Link with IT training programs
25. Develop portable credential

Subcategory Mapping

26. Leverage existing information sharing and analysis
27. Establish skills standards
28. Develop customer driven model
29. Host community forums for sharing existing geospatial information
30. Create geospatial certification programs as adjunct to other fields for professionals in other
31. ID target industries desiring targeted training
32. Define business functions and look at where those functions are performed
33. Develop workshop and training programs for decision-makers and mgrs; skills centers and community
34. Create a reference guide to understand where needs, applications, and programs are
35. Develop a geospatial not-for-profit

Subcategory Deployment

36. Deploy core training K-12 and CC students and teachers
37. Deploy training materials in appropriate area
38. Needs/Requirements
39. Align with existing K-16 initiatives (geospatial)
40. Establish geospatial coordinators. at one stops
41. Align non-credit courses with local WIB's
42. Sharing and Leveraging resources

<u>Image and Outreach to the Public Break out</u>

Subcategory Data and Definition

43. Create training programs that include classroom and application
44. Portal for ED programs as well as jobs (web based?)
45. Initial deployment to GIS specific through move to broader industry
46. Dare to Dream
47. Seed funding to stimulate user application
48. Use geospatial technology to identify workforce force gaps with one-stops, training providers, and job openings
49. Place for small business to go for networking expertise and advise about geospatial technology without having a fee attached. Geospatial enabled business
50. Have industry get rid of hype (Clancy movies)
51. Geospatial technology has a common definition commonly understood
52. A national strategy for geospatial technology

53. Develop a plan of action to blend industry segments, e.g., MIS & IT
54. Link the resources of academia and industry and workforce boards to address the image challenge and integrate resources to make an impact.
55. Get local academics in the room to view real industry projects to see cutting-edge of technology
56. Develop image strategies using local, state, commercial, federal and tribal governments
57. Develop an x/y chart demonstrating Geospatial services vs. needs
58. Outreach to youth early on
59. National event highlighting capabilities of Geospatial technology
60. Inventory work already done to define issues
61. Create academic industry forum to assess needed skills and requisite training
62. Identify and disseminate occupational codes and other LMI associated with Geospatial of current and projected employment
63. Survey industry for future spending
64. More focused meeting with specific industry sectors to identify market requirements
65. Highlight elite careers to young people using Geospatial thinking with practical applications
66. Inventory and coordinate the movement of, and add, GIS to business schools' curriculum
67. Define industry with collection of: disciplines, technology and thinking skills
68. Critical to identify definition of the industry then use standard marketing to raise awareness … identifying audience and tailoring message.
69. Narrow the focus of the industry to the segments that use the technology
70. Educate potential industry entrants on classified aspect and requirements for security clearance
71. Develop a message that demonstrates Geospatial as an enabler of other location applications
72. Partner with SBA offices to identify existence of industry specialists and bring spatial thinking to the entrepreneurs business and marketing plan development
73. Promote the mission of Geospatial technology and information
74. Develop an academic and industry communications strategy through the federal, state and local partners identifying what skills are required and map to industry standards
75. Improve advertising of spatial thinking as a job requirement by key HR personnel (promote the value of …)
76. Promote Geospatial education as a reachable science and engineering degree (CCs and retraining)
77. Define emerging industry in academic literature
78. Promote definition through PSAs, and develop a reference guide for HR
79. Create linkages beyond industry-specific professionals to others that think spatially
80. Create profiles of Geospatial professionals to make the industry more human
81. Promote exciting aspects of the industry – "make it sexy"
82. Develop a task/advisory force to "vet" programs and spending

Dare to Dream

83. Text message youth on their cell phones – "Get Spatial" – with phone number and website
84. Make a SIMS Geospatial cell phone game
85. Pop culture icon as spokesperson (Similar to milk commercial "Got Spatial)
86. Geospatial reality TV show
87. Game Boy-esque activity –"zoom up, find out where you are"
88. Bottle cap (soft drink challenge)
89. City-wide Easter egg hunt
90. Advertising during movie trailers, also on airplanes
91. E.T. "Find Home'
92. Show the progression of technology through the presidents, Thomas Jefferson to George Bush
93. Put GPS technology in the hands of explorers
94. "Trading Geospatial" as opposed to "Trading Spaces"
95. Bumper Sticker: "We know where you are, do you?"
96. Easy access to remote imagery to home via the web
97. Make technology common, e.g., location implants in humans

<u>Pipeline Break out</u>

Subcategory Recruitment

98. Provide industry resources to be retained at government transition offices.
99. Job seekers could benefit from having access to information about forecasts of growth trends and projections for specific sectors and skills within the geospatial industry (geospatial is a broad industry/job seekers must target).
100. Conduct GIS days for elementary and high school students – high growth career opportunities.
101. Involve K-14 teachers and guidance counselors in hands-on GIS courses.
102. Provide shadowing opportunities within a GIS application department or shop.
103. Internship programs: Colleges and small business to give students better understanding of field. Give student college credit instead of salary to offset cost to small business.
104. Offer internships and cooperative education opportunities.
105. Industry representatives form "awareness" groups at colleges/high schools to expose industry opportunities to next generation workforce.
106. Establish contact with student organizations (not limited those in the geospatial realm).
107. Publicity to teachers and educators so they may pass information to their students.
108. Presentations to college-bound high school students
109. ID career paths in industry – show model to high school (students, parents, counselors)
110. Industry scholarships for two year training
111. Get people excited – do media campaign

Table of Contents

- Certificates
- AA Degree
- Bachelor
- Etc.

142. “E” leaving for 24/7 instruction
143. Modularize curriculum to allow easier access
144. Enhance employee “value” with geospatial credentials defined by recognized
    a) Degree Programs
    b) Geospatial Technology Certifications
145. Association with Recognized Geospatial Organizations (i.e., program management institute)
146. Work with community colleges to develop skills upgrade curriculum for workers.

Appendix E

Online Web Tool Solutions

1. Leveraging Workforce Investment Boards to build awareness;
2. Developing an understanding of the industry definition, size and scope;
3. Working with Federal partners to validate the Geospatial Technology Competency Model, including agency specific applications. Integrate geospatial competencies in the Geospatial Technology Competency Model with required competencies for other high growth job training;
4. Addressing the national need for geospatial literacy across the curriculum at K-14 level of public education, and continue with coverage of the need for those skills across America's workforce spectrum;
5. Utilizing the structure established by the Workforce Investment Act to establish training programs for incumbent workers, with incentives for employers to create a more GIS-literate workforce;
6. Building outreach and awareness starting at K with a strong emphasis on careers beginning in the middle school technology classroom. Distance learning programs can be used to highlight this new/emerging industry and workforce opportunity;
7. Developing educational alliance programs for next generation workers with top universities specializing in work (on-the-job training) projects with internship opportunities and technology grants from companies for software/hardware support for students;
8. Help build a 2 + 2 + 2 geospatial curriculum;
9. Develop an ROI evaluation frame work;
10. Consider translation for outreach awareness building to the Hispanic population;
11. Promote geospatial literacy and competency for incumbent workers;
12. Provide continuing education opportunities so that workers can continually improve their skill sets as technology changes so rapidly;
13. Building awareness of the scope of work to partnering industries, the wide utility and application of this workforce issue (marketable and transferable skills)
14. Build a centralized clearing house of geospatial workforce development efforts to link those in need of information to those that have been working on these projects. Much information exists;
15. Mapping core geospatial competencies to specific applications such as forestry;
16. Developing a survey/information gathering of recent hires to better understand what attracted them to the field to get more people in the pipeline;
17. Developing a two part test with a hands-on skills component and a more standard test with terms; and,
18. Developing state-level pilot program to address public workforce capacity and awareness using the e 3 model.

Appendix F –Geospatial Technology Industry Environmental Scan

This is a living document that will be updated as new information emerges.

A high growth industry is defined as an industry or sector predicted to encounter either high growth in new jobs or a high rate of change in its workforce. The Geospatial Technology industry was selected as a high growth industry because of its anticipated growth potential. The worldwide market for geospatial technologies is projected to have annual revenues of $30 billion by 2005.[1] The Bureau of Labor Statistics does not have a separate industry categorization for geospatial technology, as this seems to be an emerging field. Documented employment and growth projections for this industry appear to be limited thus far.

What is Geospatial? According to a report prepared by the Geospatial Workforce Development Center at The University of Southern Mississippi in September 2001, the 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." Such tools include aerial and satellite remote sensing imagery, the Global Positioning System (GPS), and computerized geographic information systems (GIS). Geospatial skill sets are embedded in applications and cross-cutting industries and organizations but have not yet been widely adopted in many occupations that could benefit from these technologies.

Industry Profile:

Geospatial Companies:

Information cannot yet be located on which companies have the largest sales in the Geospatial Technology industry. Information has been found on which companies are engaged in some aspect of this field, many of which are major defense and high tech firms. The Spatial Technologies Industry Association lists the following companies on their membership list:

- 3001, Atlantic Technologies, Autodesk, BAE SYSTEMS, Bentley Systems, Boeing Autometric, BTG, ComCARE Alliance, Dewberry, Digital Globe, EarthData, ESRI, Fourwinds Technology, Garmin, G.C.R. and Associates, Geographic Data Technology (GDT), General Dynamics, GeoSpatial Concepts, Harris, IBM, Intergraph, Intermap Technologies Corporation, IONIC Enterprise, Laser-Scan, Leica Geosystems, MapInfo, mPOWER3/EMERGE, Navigation Technologies, Northrop Grumman, Oracle, PCI Geomatics, PixSell, Questerra, Raytheon, Research Systems, SAIC, SDS, Space Imaging, Sun Microsystems, Techni Graphics Systems, Tele Atlas North America, Trimble, Vality Technology, ERIM International, VISTA Information Technologies, and Voxiva.

Economic and Employment Picture:

General Industry Overview

[1]: "Building the Geospatial Workforce" by Annulis, Carr, and Gaudet, 2002, in Urban and Regional Informational Systems Association Special Education Issue.

- As of 2002, the current worldwide market for geospatial technologies was estimated at $5 billion. The market is projected to have annual revenues of $30 billion by 2005, consisting of: $20 billion in the Remote Sensing market and $10 billion in the GIS market, according to "Building the Geospatial Workforce," in *Urban and Regional Informational Systems Association Special Education Issue.*
- The market for the geospatial industry, particularly remote sensing, is growing by 5 to 14 percent per year, and this growth rate is expected to continue throughout this decade. (Source: www.asprs.org, ASPRS, The Imaging and Geospatial Information Society, 2004)
- Geospatial Technology information is used for a diverse set of tasks including: planning urban growth, managing forests, implementing precision farming, assessing insurance claims, siting ATM machines, routing 911 calls, designing a cellular phone network, guiding "intelligent" vehicles, operating a utility, mapping natural hazards and disasters, minimizing water pollution, assessing environmental impact, studying global climate change, and designing roads. (Source: www.asprs.org, ASPRS, The Imaging and Geospatial Information Society)
- Careers in imaging and geospatial technology disciplines are available in many segments of commercial, public, government and academic communities. Pam Frugoli with O*NET, the U.S. Department of Labor's Occupational Information Network, has identified a number of occupations that may require geospatial competencies, including: cartographers, photogrammetrists, surveyors, civil drafters, electrical drafters, mechanical drafters, aerospace engineering technicians, civil engineering technicians, electrical engineering technicians, environmental engineering technicians, industrial engineering technicians, mechanical engineer technicians, surveying technicians, mapping technicians, soil conservationists, range managers, foresters, geological data technicians, and geological sample test technicians.
- Other occupations listed by ASPRS include geographers, physical scientists, computer scientists, GIS analysts, database administrators, and remote sensing scientists.
- Industries that use GIS software include: retail, transportation/logistics, real estate, finance, environmental agencies, and all levels of government. (Source: DIRECTIONSMAG, 12 August 2003)
- The NASA Earth Science Applications Program has identified 12 national geospatial applications that are priorities of Congress and the Executive branch. These applications include: agricultural competitiveness, air quality management, aviation safety, carbon management, coastal management, community growth, community preparedness for disaster management, energy forecasting, homeland security, invasive species, public health, and water management.

Recent Employment Trends and Developments

- Geospatial products and specialists are expected to play a large role in homeland security activities. Information gathering needs to protect critical infrastructure have resulted in an enormous increase in the demand for such skills and jobs. Anecdotal data suggests that federal agencies, such as the National Imagery and Mapping Agency (NIMA), need more than 800 imagery analysts right now, and over 7,000 of their workers will need additional training in remote sensing technology within the next three years. (Source: Lorraine Castro, NIMA Human Resources Department)

- To date, the Federal Government is the largest provider of geospatial data for the industry, while end users of the data are smaller businesses.
- Both state and federal governments are significant employers of individuals pursuing careers in geospatial technology. Federal agencies offering opportunities in this field are USGS, NOAA, USFS, EPA, NASA, NIMA, and BLM. At the state level, agencies that carry out activities in planning, environment, resources, transportation and geology offer employment opportunities. (Source: www.asprs.org,ASPRS)
- In a survey done by NASA's National Workforce Development Education and Training Initiative (NWDETI), it was determined that less than 30 percent of the needs for data are currently being met for all areas of the industry. Some sectors report that their needs are being met at less than a 10 percent level.
- In all sectors using remote sensing technology, research on government, academia, and the Geospatial Technology industry documented a significant gap between what is available to the industry and what is needed for their use. (Source: ASPRS)
- An estimated 175,000 people are employed in the U.S. remote sensing and geospatial information industry. It is a rapidly growing segment of the much larger information industry. (Source: ASPRS, "10-Year Industry Forecast," Executive Summary)
- The development of a capable workforce is of major concern for continued industry growth. Lack of retention of entry-level workers is hampering the long-term health of the industry, according to a study available through the ASPRS. (Source: ASPRS, "10-Year Industry Forecast," Executive Summary)
- In a 1998 survey of geospatial product and service providers, 87 percent of respondents expressed difficulty filling positions requiring geospatial technology skills. (Source: NWDETI Business Implementation Plan)
- Surveyors, cartographers, photogrammetrists, and surveying technicians held about 124,000 jobs in 2002. (Source: www.bls.gov/oco/ocos040.htm, Occupational Outlook Handbook, 2004-05 edition)
- Architectural, engineering, and related services firms – including companies that provided surveying and mapping services to other industries on a contract basis – provided about two-thirds of jobs for these workers. (Source: www.bls.gov/oco/ocos040.htm, Occupational Outlook Handbook, 2004-05 edition)
- Federal, state, and local governmental agencies provided almost one in six jobs of the 124,000 surveyor, cartographer, photogrammetrist, and surveying technician jobs. (Source: www.bls.gov/oco/ocos040.htm, Occupational Outlook Handbook, 2004-05 edition)
- Other professions using geospatial technologies include environmental scientists, geoscientists, and hydrologists, employing about 101,000 in 2002. Environmental scientists accounted for 65,000 of the total; geoscientists, 28,000; and hydrologists, 8,000. (Source: www.bls.gov/oco/ocos040.htm, Occupational Outlook Handbook, 2004-05 edition)

Occupational Statistics and Projections**:**

- Overall employment for these occupations is projected to grow about as fast as the average for all occupations through the year 2012. The widespread availability and use of advanced technologies, such as GPS, GIS, and remote sensing, will continue to increase both the accuracy and productivity of these workers, resulting in modest overall growth in employment. However, job openings will continue to result from the need to replace

workers who transfer to other occupations or who leave the labor force altogether. (Source: www.bls.gov/oco/ocos040.htm, Occupational Outlook Handbook, 2004-05 edition)

- Employment of environmental scientists and hydrologists is expected to grow faster than the average for all occupations through 2012, while employment of geoscientists is expected to grow about as fast as the average. (Source: www.bls.gov/oco/ocos040.htm, Occupational Outlook Handbook, 2004-05 edition)
- Approximately 500,000 U.S. jobs require GIS skills. Estimates project that there will be approximately a 15% increase in GIS jobs per year, which could translate into as many as 75,000 new hires per year in GIS related jobs. Examples of GIS employment areas include environmental management, urban planning, emergency management, site selection, transportation and utilities planning. (Source: Osa Brand, Association of American Geographers presentation, Workforce Innovations 2003 National Conference, 7/03)

Education and Training

- Education and training requirements for occupations utilizing geospatial technologies generally require at least a two-year degree from a community college or technical institution. There is a substantial demand for technicians in geospatial information technology for individuals who do not wish to pursue an advanced degree. Certificate programs are the most likely course for training. (Source: www.asprs.org,ASPRS)
- College-preparatory courses that emphasize the sciences are suggested for individuals interested in pursuing careers in photogrammetry, remote sensing, and geographical information systems (GIS). (Source: www.asprs.org, ASPRS)
- Many two-year academic and technical institutions offer education and training in photogrammetry, remote sensing and GIS, and in related fields. Associate degree and certificate programs in GIS, surveying, photogrammetry, and similar curricula provide a sound foundation for work experience or for transfer to other academic institutions for further education. (Source: www.asprs.org, ASPRS)
- It is highly recommended that any individual wishing to pursue a career in photogrammetry, remote sensing, and GIS participate in an internship program to obtain "hands-on" experience as part of their preparation for employment. (Source: www.asprs.org, ASPRS)
- Like many rapidly advancing high-tech fields, continuing education in photogrammetry, remote sensing, and GIS is necessary to keep current as a professional. (Source: www.asprs.org, ASPRS)
- Beginners with postsecondary school training in surveying can usually start as technicians or assistants. With on-the-job experience and formal training in surveying – obtained either in an institutional program or from a correspondence school – workers may advance to senior survey technician, then to party chief, and in some cases, to licensed surveyor (depending on state licensing requirements). (Source: BLS, Occupational Outlook Handbook, 2002-03 edition)

Occupational Statistics, Training and Earnings for Select Geospatial-related Occupations[2]

Source: The Bureau of Labor Statistics

Occupation	Total Employment (000's)		2002-2012 change in total employment		2002 Percent Self-Employed	2002 Median Annual Earnings	Education/ Training Category
	2002	2012	Number (000's)	Percent			
Environmental engineers	47	65	18	38.2	0.4	$61,410	Bachelor's degree
Environmental Engineering Technicians	19	24	5	28.4	0.4	$36,850	Associate's degree
Surveying and Mapping Technicians	60	74	14	23.1	5.5	$29,230	On the job training
Cartographers & photogrammetrists	9	10	1	15.1	3.3	$42,870	Bachelor's degree
Geoscientists, except hydrologists and geographers	28	31	3	11.5	2.7	$67,470	Master's degree
All other drafters, engineering, and mapping technicians	150	167	17	11.3	4.5	$44,450	Associate's degree
Mechanical Engineering Technicians	55	61	6	11.0	0.4	$41,280	Associate's degree
Electrical & Electronic Engineering Technicians	204	224	20	10.0	0.4	$42,950	Associate's degree
Engineering managers	212	231	20	9.2	0.1	$90,930	Bachelor's or higher degree plus work experience
Industrial Engineering Technicians	62	67	5	8.7	0.4	$41,910	Associate's degree
Civil Engineering Technicians	92	99	7	7.6	0.4	$37,720	Associate's degree
Surveyors	56	58	2	4.2	3.5	$39,970	Bachelor's degree
Architectural and Civil Drafters	106	110	4	4.2	3.7	$37,330	Postsecondary vocational award
Mechanical Drafters	72	74	1	1.9	3.7	$40,730	Postsecondary vocational award
Aerospace Engineering & Operations Technicians	15	15	0	1.5	0.4	$51,650	Associate's degree

[2] The list of occupations identified is not comprehensive in scope for the industry as a whole. For a comprehensive list of occupations go to www.bls.gov. Additionally, please note that these occupations are far broader in employment scope than just for the geospatial technology industry, i.e., geospatial related positions are subsets of these occupational categories.

Policy and Legislative Issues:

- The Management Association for Private Photogrammetric Surveyors (MAPPS) primarily takes positions that further procurement opportunities for its members with the Federal government.
- In 2001 the White House Research Office polled each Federal Agency requesting information on the potential uses of remotely sensed data. One aspect of their query was to determine how the missions of the agencies could be furthered by use of the data.

Industry Interaction with Public Workforce System:

- The National Workforce Development Education and Training Initiative and their Federal Partners have established an Informal Program Review Panel made up of companies who are heavily involved in the Geospatial industry and representatives from several Federal and State Agencies involved with this effort.
- To date, the interaction with the Workforce System has been solely at the National level.
- Training capacity appears limited for specialized geospatial occupations, with some college course focus on Geographical Information Systems (GIS) related content.
- Challenges for publicly funded training programs in the Geospatial industry include:
  - New industry, where entry level workers are often not yet aware of the potential that the industry offers – more need to identify job openings and internships to build interest with the population.
  - Hiring a newly trained person is often very expensive for companies and sometimes it is easier to hire someone already trained – also, many jobs require more than short-term training (at least a Bachelor degree).
  - Employment opportunities in Geospatial appear to be somewhat regional in nature – people trained in one state/region may have to relocate to find jobs in another.
  - The technology keeps changing and getting updated – workers in this industry must keep up in their training.
  - Limited accessibility with expensive training, particularly given the expense of GIS training software.
  - Insufficient training capacity, including a lack of instructors who possess Geospatial knowledge and the skills to teach it.
  - Insufficient Geospatial related instruction at the secondary school level.

Federal Funding for the Industry:

- The National Workforce Development Education and Training Initiative is an effort of the Office of Education and the Earth Science Enterprise, both located at the NASA John C. Stennis Space Center. The initiative is a customer-focused effort to meet workforce demands for the emerging multi-billion dollar geospatial industry. The Geospatial Workforce Development Center (Geo WDC) is housed at The University of Southern Mississippi and is designed to be a first source of information of geospatial workforce training and development.
- In the Department of Defense (DOD) budget for 2002, over $1 million was listed for training and certifications for personnel in remote sensing.