The Geospatial Industry: A Perspective on Technology Diffusion

May 18, 2006

Susan Wachter
Richard B. Worley Professor of Financial Management
Professor of Real Estate and Finance
The Wharton School
University of Pennsylvania
Philadelphia, PA
Wachter@wharton.upenn.edu
Corresponding Author

Larry Hirschorn
Principal
Center for Applied Research
Philadelphia, PA

Harris Sokoloff
Center for School Study Councils
Graduate School of Education
University of Pennsylvania
Philadelphia, PA

Harris M. Steinberg, AIA
Executive Director
Penn Praxis
School of Design
University of Pennsylvania
Philadelphia, PA

Introduction

This paper presents reflections on the thinking and work accomplished by participants in two roundtables on the geospatial industry of the future. Under a Department of Labor grant, AAG, GITA and the Wharton School's GIS Lab, convened two Leadership Roundtables on the Geospatial Industry: Current Status and Evolving Needs, held on October 6, 2005 and January 27, 2006, and attended by over 100 industry leaders. Both roundtables provided an opportunity for industry and academic leaders to evaluate challenges and opportunities in the future development of the geospatial technology industry and its workforce needs; and a feedback mechanism on the views presented at the initial roundtable elicited almost 100 detailed responses. Together these responses and the roundtable discussions provide a basis for describing an evolving consensus first on how the geospatial industry defines itself and second on steps to respond to workforce development needs for the future.

The roundtables were part of the DOL sponsored grant to respond to workforce needs in fast growing industries of the future. The DOL has designated the geospatial industry as one of 14 high growth industries. The purpose of the roundtables was to help define the industry and its components and also to assist in identifying and responding to future workforce needs. As a second component of the grant, AAG and GITA will develop GIWIS, an information tool both to bring workers and potential employers together now and also to identify trends to shape policy responses to workforce development needs. To advance our understanding of the evolution of this fast growing emerging industry and these needs, participants in the roundtables, presented their views on the industry and its evolution as well as on current and future workforce needs. "Defining and Communicating Geospatial Technology Industry Workforce Demand," by Mary Ann Stewart and Ivan Cheung, summarizes views expressed at the initial roundtable, and a feedback mechanism was offered to participants in the initial roundtable to solicit further responses on industry definition, components, and necessary roles and competencies of the geospatial workforce of the future was offered. Second roundtable participants considered these responses in group discussions. Appendices to this paper summarize these responses. As a result of this work we believe that there is an evolving consensus on the industry and its workforce needs; we also believe that we have learned a great deal about the challenges in measuring demand in this fast evolving industry and second about the need for industry and educational leaders to work together to respond to the demand for technology workers in the geospatial industry of the future.

This paper offers our views on these issues. It is divided into five sections. In the first section, we take up the question of defining the industry and suggest that we are describing an industry that is based on a fast evolving infrastructural technology. In the second section, we look at how an infrastructural technology grows and suggest that it follows a sigmoid curve of expansion. This creates challenges for forecasting demand. In the third section, we introduce the concept of plan coordination between employers and educators as a substitute for forecasting, and we examine some models of plan coordination from the history of other occupations. In the fourth section, we link the challenge of plan coordination to our concept of a growth trajectory. Finally, in the fifth section we talk about how outsourcing might affect plan coordination, followed by a summary of the discussion. We also include appendices which describe the process used to come to our conclusions.

I. Defining the Geospatial Industry

In their excellent paper, "Defining and Communicating Geospatial Technology Industry Workforce Demand", Mary Ann Stewart and Ivan Cheung summarize the issues and questions raised by the participants in the initial roundtable and by the responders to the feedback mechanism in the discussion of how to define the industry and its segments, as well as how to project its growth and future workforce development needs. One conclusion we can draw from the discussions at the conferences and the feedback responses is that it is a misnomer to think of the geospatial industry simply as a relatively static set-apart industry in the sense that the market for copy machines or personal computers constitute a distinct market segment.

Instead, geospatial technology, like nanotechnology or telecommunication, is better thought of as an infrastructure technology-providing industry. Such industries shape the creation and delivery of value across a wide range of market segments. They offer decision makers in many industries new capabilities.

Infrastructure technology industries typically have short term cost impacts and long term value impacts. For example, the highway system reduced commute times from the suburbs to the central business district when it was first built. Over the longer run, however, the highway system decentralized residence and industry, giving rise to a new pattern of living. In the process, the central business district, the earliest focal location for the highway system, became less salient. Similarly, consider the telephone. Initially, the phone enabled people to "meet" without having to be in the same place. This was its cost reduction impact. But over the longer run, the phone enabled people to sustain much larger personal networks of friends and colleagues. This was its value creation impact. In both of these examples, the second value-creating phase far outweighed in significance the first cost-reducing phase.

Geospatial technology will most likely follow a similar trajectory. In the first instance, it reduces the costs of mapping and monitoring the spatial configuration of assets, such as pipes and supplies, and was, in fact, used initially in the resource-based industries. In the second developmental phase, it offers new uses, such as logistics, store-siting, fire-fighting, supply-chain management, traffic control, congestion pricing, individual trip planning, personal navigation, infectious diseases tracking, etc. Over the longer run, as an infrastructural technology diffuses, "the medium (the technology) becomes the message". For example, geospatial technologies enable decision makers in the widest range of sectors to think and reason "spatially." In this sense it creates a new "literacy." Indeed, many people at the initial roundtable noted that over the long run, geospatial tools will become an integral element of executive decision making, in the same way that spreadsheets facilitate financial thinking and market segmentation methods shape product and pricing decisions.

The continuing evolution of a definition of the industry was reflected in the discussion during the second roundtable (January 27, 2006). While grappling with whether it was better to refer to the "geospatial technology industry" or simply the "geospatial industry", there was an emerging agreement around the following definition:

> "The geospatial technology industry acquires, manages, interprets, integrates, displays, analyzes or otherwise uses data focusing on the geographic, temporal and spatial context for decision support."[1]

This definition acknowledges that geospatial technology comprises its own industry while also creating an increasingly important value-creating function, serving actors and decision makers across a progressively wider range of industries. The roundtable participants tended also to view the industry as not only a field of practice, but also as a provider of tools that transform the way businesses and individuals make spatial decisions. (For a listing of suggested alternate definitions, see Appendix 1.)

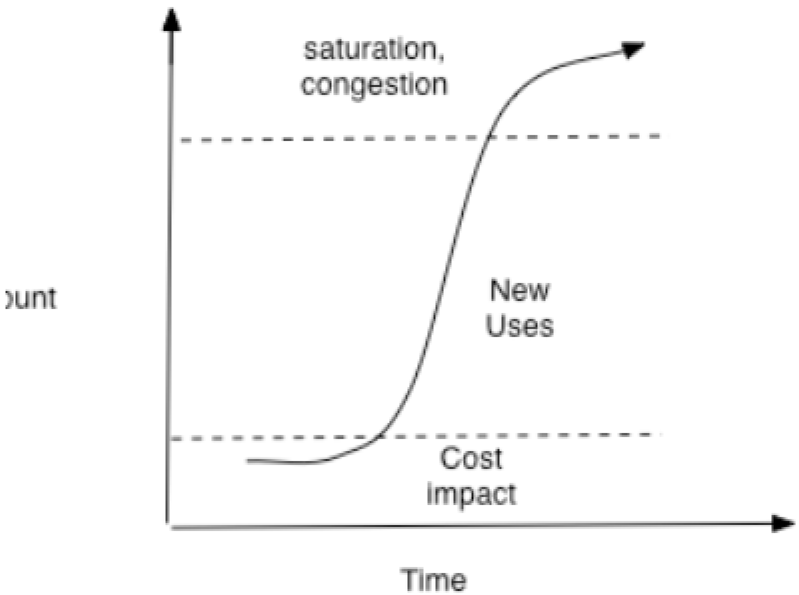
II. The Trajectory of Growth and the Problem of Forecasting

It is useful to ask: what is at stake in highlighting the distinctive features associated with the diffusion of an infrastructural technology? It affects how we think about forecasting and in particular the forecasting of future workforce development needs. When we take the classical approach to forecasting the demand for workers schooled in a particular skill, we combine the forecasted market demand for products that use such workers with an empirical estimate of the number of skilled workers required to produce one unit of each product, which is called the "input-output ratio." With these numbers, forecasting is simply a matter of multiplying the forecasted product demand by the relevant input/output ratio and summing all of the different products. Or, to express it numerically:

$$\text{Demand} = \sum_{i=1}^{i=n} D(i)k(i)$$

where there are 'n' products, 'D(i)' is the forecasted demand for the 'i''th product, and 'k(i)' is the input/output ratio for the 'i''th product.

Note that this approach is based on a straightforward and seemingly incontestable assumption--that product demand stimulates factor supply, or, as economists put it, that factor supplies are "derived demands." With infrastructure technologies, however, the causal arrows run in the reverse direction. The new infrastructure, whether it is a highway, the Internet, or a new tool, creates new uses that, in turn, create more demand for the technology or tool. Highways disperse residences and businesses, which creates a demand for more highways. This is why the history of these infrastructural technologies follows the classic sigmoid curve:



Initially, the technology diffuses slowly as it offers cost advantages. It then reaches a "take-off stage," where it creates new uses, stimulating its own demand. Finally, it reaches a saturation or congestion phase, where the number of uses stabilizes, and the technology offers primarily incremental cost reductions, if any advantages at all. This trajectory makes forecasting difficult.

We can make *some* progress in forecasting if we choose to look at the technology more narrowly, and focus primarily on the demand for particular tools—in other words, on the prospects facing particular tool-suppliers. For example, one roundtable group divided the suppliers into the following categories; hardware, software, satellite and aerial, educators, consulting companies and system integrators. Similarly, the American Society for Photogrammetry and Remote Sensing produced a ten-year revenue forecast for its piece of the industry. It estimates that revenue will rise at about 9% per year from 2002 to 2012, reaching a level near $6.5 billion by 2012. However, these revenue forecasts for tool producers do not help us estimate the total demand for geospatial workers. Just as we cannot predict the demand for people skilled in the use of an information technology tool such as Excel by looking at the number of people Microsoft employs to support it, we cannot use estimates of the revenue of current geospatial tool suppliers to project the demand for workers skilled in using such tools.

We began to see this dynamic when we analyze the results from the feedback mechanism, particularly in responses to questions about how best to understand current and emerging market segmentation. Typical modes of segmentation would focus *either* on division by technology categories *or* on division by application groups.

Participants in both the feedback mechanism and the January 27 roundtable discussions resisted such forced-choice segmentation. Instead, they argued that the industry is best characterized by specific technology as well as by application area. Moreover, there was some agreement that the industry may best be viewed in an all-encompassing view as currently experiencing movement *from* a geographic information systems (GIS) industry *to* a geospatial industry which seemingly has a more inclusive and broader connotation than does "GIS." This connotation may facilitate including the expanding range of applications to which geospatial tools are being put, as well as the expanding set of technology categories and skills that are required across those applications.

Thus, the following kind of matrix framework emerged from the January roundtable as presenting a richer view of the industry:

User Applications (field of practice) / Technology Categories	Utilities	Telecom	Health care	Agriculture	Etc
Photogrammetry					
Geographic Management Systems					
Work order systems					
AVL					
ETC					

Such a matrix has an advantage of providing information on the evolution of industry segments' use of technology.

A matrix approach may also increase access to the industry by those seeking positions or potential employers by enabling those with specific skill sets to match their abilities to fields and user applications. This may be particularly useful because of the diversity of users, which includes not just those with entry level skills, but also those with expertise in different substantive fields. Nonetheless, there was an affirmation of the utility of employment classifications by technology, if a choice between the two methods was necessary. As noted by one group in the January roundtable: "Job seekers need to choose fields by technical key words for their job searches." (See Appendix 2 for participants' suggestions on optimal job classifications.)

Moreover, there was a great deal of support at the January roundtable for the utility of generic employment classifications for entry level employees, such as GIS analyst/technician/manager, that such job titles and classifications are currently in common use, it would be advisable to link jobs to candidates with such generic job titles. (For a full listing of such suggested generic job titles, see Appendix 3.) Thus while there was a common view that educators should work with the personnel departments of local companies to develop standard job descriptions, nonetheless there appears to be a common set of job titles that are currently in use that identify a recognized set of competencies and skills.

There was also consensus from roundtable participants and responses to the feedback mechanism on the need for additional SOC job categories, such as these generic employment titles, and the potential for tracking the growth of the industry and its components as well as the demand for skilled employees going forward.

From the conference discussion of the evolution of the industry and the difficulty in identifying job growth for skilled workers and current gaps between job candidate skills and employer needs, it is clear that the development of the GIWIS system, to be undertaken by AAG and GITA, will be a critical and highly useful step. At senior levels of employment, conference participants also expressed the view that applied domain knowledge and core knowledge, together with management capabilities, as described further below, are important in order to bring about the next stage of the diffusion process. Nonetheless, as technology continues its rapid evolution and diffusion, it is difficult to forecast the need for the future labor force at the entry or senior levels for the nation as a whole or for specific geographical areas.

III. Plan-Coordination

What can industry and educational leaders in a domain do when forecasting is so difficult? In particular, how can we assess future deficits of workers skilled in the use of geospatial tools? In the absence of reliable estimates we must rely on ongoing *plan coordination* between users and educators.

Indeed, participants in both roundtables focused a great deal on how better to coordinate employers' needs for skilled geospatial workers and the size and scope of the programs that educators mount to train these workers. For example, one industry group suggested that employers and educators could create workplace projects through which workers can earn school credit. In addition, this group suggested employers could join educators on curriculum committees as the latter shape a course of study for students interested in geospatial careers.

The members of this industry group also had requests of educators; for example, that educators should incorporate real world projects into the curriculum. Similarly, a group of educators suggested that they could merge computer science courses with physical and social science courses, that they could link classroom learning to actual practice, that they could give credit to students who intern with employers, and that they could pay attention to the gap between local employers' needs and the number of students graduating with geospatial skills. They also noted that, because the tools are evolving quickly, they must pay attention to the faculty members' own professional development. Just as students have to go to school, faculty members also "have to go to work" in order to be more effective as instructors.

Critical to plan coordination, as the industry evolves, is an emerging consensus around skills and competencies that could focus training and education to meet the needs of employees and employers. At one end of the spectrum, there are a set of skills that are required for entry into the geospatial industry, regardless of the user application/field of practice (see Matrix earlier). Toward the other end of the spectrum, there are sets of more complex skills (for example, for jobs at levels 6-9 of the ETA Industry Competency Initiative model) requiring specific knowledge and technical competencies that may necessitate both academic and on-the-job training. Finally, there are sets of managerial competencies that may cut across fields. As we saw in the concluding sessions of the January conference, competencies for these managerial roles are now and are likely to be increasingly important as the industry expands.

One of the most creative tensions in thinking through these training, education, and licensing issues is between the academic and practice models for understanding the knowledge, skills, and activities essential for this industry. Gaudet et al provided a codified body of knowledge that has served the industry well since its publication in 2000. However, there was some sense in the January roundtable that their model could be usefully expanded first to link to a deeper knowledge of the core geospatial science and second to capture the pervasiveness of need for managers. For the former, the UCGIS Body of Knowledge framework provides an essential perspective on this emerging industry.

Both the demand for basic science and management capabilities are likely to increase. In particular there is likely to be increasing demand for those who can manage the technology application and diffusion process, as geospatial knowledge, skills, and technologies become an increasingly important part of the infrastructure across all industries. (See Appendix 4 for a listing of additional competencies needed as expressed by January roundtable participants.)

IV. How Plan Coordination Happens: Models from the History of the Professions and Occupations

The history of the development of professions and occupations highlights different models of education and industry coordination. Some occupations, like the modern physician, emerged out of a series of reforms, sponsored by the Rockefeller Foundation, which resulted in the closure of diploma mills and the rise of the science based medical schools. These schools joined together to regulate the size and quality of the physician workforce by creating educational standards for schools and licensing exams for medical school graduates. Here, a foundation and schools took the lead. By contrast, the profession of social work emerged out of the informal practice of serving the poor in settlement houses. Only later did schools emerge to regulate social training and licensure. Here, practitioners took the lead.

Similarly, in rapidly growing market segments or industries, companies often lead educational institutions in defining ex-post standards for an occupation. For example, the video game industry, with revenues between six and seven billion dollars, is an increasingly vital part of the entertainment sector, but only recently have schools responded by creating training programs in video game design and programming. Finally, some occupations are professionalized as the work people do changes. Thus the business school arose as a professional degree granting institution in the late nineteenth and early twentieth century when large corporations faced the challenge of selling their products to a mass market for the first time. Since the 1980's, business schools that award the MBA have played an important role in training future management consultants and investment bankers.

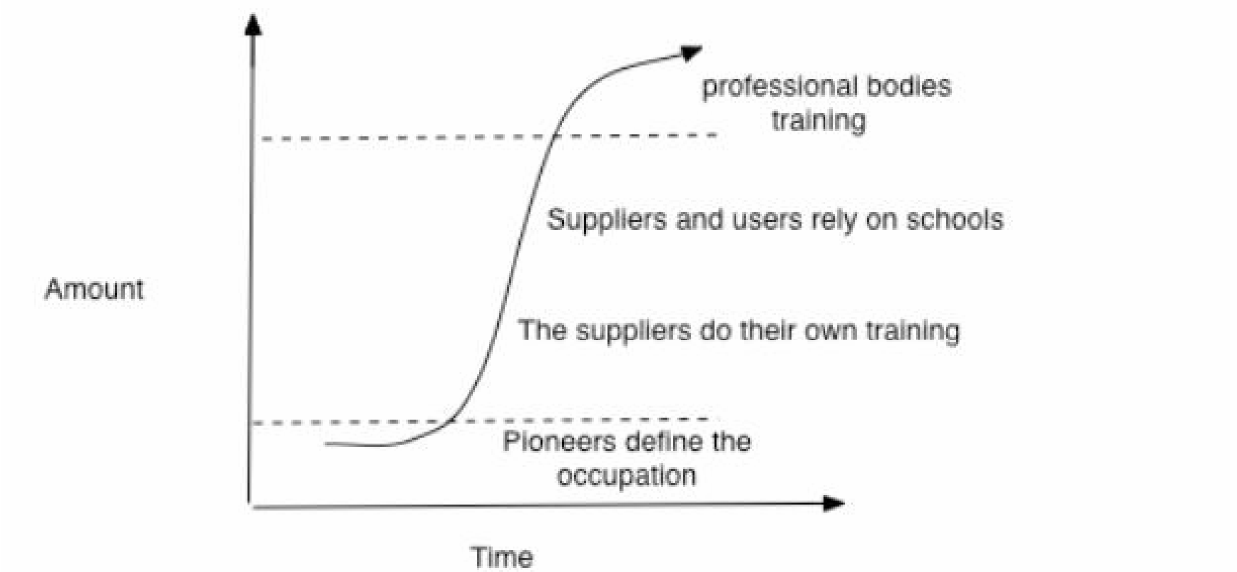
The structural link between education and industry is also shaped by whether the government is called upon to regulate the profession or occupation (as is the case in medicine) and whether the government has a national interest in how many skilled workers can take up a particular role. For example, at the initial roundtable, Jennifer McNelly from the Department of Labor noted that the government's interest in geospatial technologies stems partly from its commitment to national security. It is reasonable to suppose that the federal government's ability to secure its citizens' safety will depend on having access, directly or indirectly, to a skilled and loyal work force, able to track the location and status of a wide range of assets. When the government takes up a compelling national interest in the training of professionals, such as in health or national security, it is very likely that it will provide incentives and support to both industry and education to train and license professionals so that they meet a particular level of competence.

The Growth Trajectory Again

The growth trajectory we described above also shapes the links between industry and schooling. When an industry or occupation enters its initial period of explosive growth, producers or providers face a seemingly unlimited product market and a shortage of skilled labor. Under these conditions, they are willing to invest in screening and training workers, and/or they reorganize the work so that it requires less skill. For example, Henry Ford could not have possibly hired enough skilled workers to mass-produce the Model T. Instead, he created an assembly line, which radically simplified the job. In this early phase, the importance of industry specific knowledge for fast growing segments may be sufficiently large that firms can provide training. Nonetheless, as the industry grows and develops applications, there will be a demand for early career professionals with transferable skills and a demand for a common mechanism to provide such training.

Moreover, as the industry continues to expand, firms face more competition, customers become price sensitive, and workers move between firms when pay differentials are significant or when the conditions of work differ. The business problem shifts from securing supplies and resources to securing and keeping customers. At this stage, companies have an incentive to share the cost of training with their future workers, who, in effect, pay for their own schooling while they are students, or with the government, which subsidizes their training. When this happens, general-purpose users of the technology who cannot afford to train geospatial specialists, for example developers who use geospatial data to identify and acquire land parcels, will grow to rely on schools as well. In a later stage, as the industry matures and its technology stabilizes, training professional bodies may play a role both in training and in setting standards for skills. Today the industry is in a growth phase where schooling is necessary component of skill provision, although industry and professional bodies also are contributing to skill development. Training in a educational setting has the advantage of conveying basic knowledge for the developing technology, which is critically important in a fast growing emerging industry. Views expressed at the roundtables were consistent with this and emphasized the need to support training at all levels, at undergraduate and graduate institutions and, importantly at community colleges as well.

We propose the following links between our earlier trajectory of growth and the methods for provisioning skilled workers:



V. Outsourcing

Industry participants at the conferences pointed to one additional factor that will shape the relationship between schools and employers—the degree to which geospatial work and/or training can be outsourced. There are precedents for this. After all, the United States depends on a large number of foreign medical graduates to staff its residency positions in hospitals, and, of course, software producers are relying increasingly on companies in India to supply software engineering skills. One question is whether the geospatial industry, in terms of both suppliers and users, will expand so quickly that employers will turn to managing the gap between the supply and demand for workers by either outsourcing the work, and importantly the training, or both. This outcome may not be consistent with national security. As advanced economies increasingly become knowledge driven, the provision of skills and knowledge will also be important to the ability to develop the new technologies that will create the geospatial industry and jobs of the future.

VI. Conclusion

Geospatial tool providers and users are most likely facing a period of significant growth. This growth trajectory makes forecasting job demand based on the concept of derived demand difficult and misleading. Instead, educators and employers should find ways to coordinate their plans. The growth trajectory itself will shape the interplay between these two groups as they each work to link labor demand to supply. In addition, the government's national security interest will affect this interplay. Finally, outsourcing can short-circuit plan coordination if and when US employers rely on foreign companies or educational institutions to provide them with the skilled workers they need to create or use geospatial tools. This and other issues about the structural and economic links between education and work in the geospatial industry of the future were the subject of two roundtables convened by the AAG, GITA and the Wharton School's GIS Lab which brought together educator and industry leaders. The Roundtables and a feedback mechanism elicited industry views (the process by which these were aggregated is explained in Appendix 5.) A major conclusion of this process which this paper underlines is that educators and industry leaders must plan together to respond to the evolving needs for training the geospatial labor force of the future.

APPENDIX 1—PROPOSED DEFINITIONS OF THE INDUSTRY

Table A. Proposed Definitions from Group Discussions--January 27, 2006

Group 1

- The geospatial technology industry acquires, manages, interprets, integrates, displays, analyzes or otherwise uses data focusing on the geographic, temporal and spatial context for decision support.

Group 2

- Geospatial technology is a scientific industry that promotes the acquisition, management, integration, analysis and display of maps, GIS, databases and imagery.

Group 3:

- The geospatial industry produces, manages and uses geographic data to help people make decisions. Geospatial professionals work in government, business, and academic in diverse specializations from environmental management to national defense.

Group 4

- The geospatial industry is a field of practices that acquires, manages, interprets, integrates, displays, analyzes, enables or otherwise uses data, science, engineering and technology focusing on the geographic temporal and spatial context.

Group 5

- The geospatial industry is a field of practice that acquires, manages, interprets, integrates, displays, analyzes and disseminates information based on geographic, temporal and spatial knowledge.

  The field includes basic and applied research, technology development and integration to satisfy business, government, general public and educational needs.

Group 6

- The geospatial technology industry acquires, manages, interprets, integrates, displays, analyzes, locates and defines the relationship among geographical features in time and space.

Group 7

- The geospatial industry is a field of practice that is concern with the research, development, and application of spatial and temporal information and technologies (e.g. GIS, GPS, R, S and others).

APPENDIX 1—PROPOSED DEFINITIONS OF THE INDUSTRY

Table B. Definition of “Geospatial Technology Industry” in Feedback Mechanism

Thirty-nine percent of feedback respondents preferred the first definition:

> “The geospatial technology industry is 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 the development and life-cycle management of information technology tools to support the above.”

Other definitions received nominal support. In the second roundtable, the above definition was the basis for discussion. Suggested changes in this definition are shown in the following appendix I.B and the resulting definitions are shown in appendix I.A.

APPENDIX 1—PROPOSED DEFINITIONS OF THE INDUSTRY

Table C. Suggested Changes to the Preferred Definition in Feedback Mechanism from Group Discussions--January 27, 2006

Group 2
- Priority: Add product/outcome "produces knowledge, products and services."
- Priority: Add example w/o limiting
- Remove: IT
- Remove last sentence.
- Example: The geospatial industry produces knowledge, products and services that acquire manage
- Add descriptive sentence.
- Example: Geospatial technology is a scientific industry that promotes the acquisition, management, integration, analysis and display of maps, GIS, databases and imagery.

Group 3:
- The geospatial industry produces, manages and uses geographic data to help people make decisions. Geospatial professionals work in government, business, and academic in diverse specializations from environmental management to national defense.

Group 4
- The geospatial industry is a field of practices that acquires, manages, interprets, integrates, displays, analyzes, enables or otherwise uses data, science, engineering and technology focusing on the geographic temporal and spatial context.
- Add:
  - Enables
  - Science and engineering
  - Technology as an element applied to fields of practice
- Remove:
  - IT as a "field of practice"
  - Sentence 2 – development of lifecycle management

Group 5
- The geospatial industry is a field of practice that acquires, manages, interprets, integrates, displays, analyzes and disseminates information based on geographic, temporal and spatial knowledge.
- The field includes basic and applied research, technology development and integration to satisfy business, government, general public and educational needs.

Group 6
- Put it in language that mom would understand.
- The geospatial technology industry acquires, manages, interprets, integrates, displays, analyzes, locates and defines the relationship among geographical features in time and space.

Group 7
- The geospatial industry is a field of practice that is concern with the research, development, and application of spatial and temporal information and technologies (e.g. GIS, GPS, R, S and others).

APPENDIX 2-Fields of Practice and Technology--January 27, 2006

Group 1

- <u>Absolutely</u> must do both! Can't pick one segmentation approach. Change the scope/concept of the pilot. Suggest using a matrix interface to drive the portal.

User apps→ Tech categories	Utilities	Telecom	Health care	Agriculture	Etc
Photog	•	•	•	•	•
GMS	•	•	•	•	•
Work order	•	•	•	•	•
AVL	•	•	•	•	•
ETC	•	•	•	•	•

Group 2

- Consensus for method 1 (5:1)
- Rationale:
    - Method 1 is related to method 2.
        - Example: "I am a trucking company in need of a cartographer"
    - Unanimous with concession to be as broad/sexy enough to attract *geek-o-phobic* workforce.
        - Example: CIA needs geologist for spying/homeland security.

Group 3

- No consensus
- #1:
    - fewer categories
    - more parsimonious (tidy) classification
    - technologies cut across application areas
- #2
    - professional rather than vocational perspectice:
        - forward looking, proactive, broader, more inclusive.

Group 4:

- Method:
    - Modification of 3 by fields of practice (i.e. domain sectors)
        - E.g. Transportation, business intelligence, water and sewer, geo-intelligence, s/w development, educational
- Reasons:
    - By technology is <u>too</u> technology focused and leaves out broad geospatial industry view

- Fields of practices are more useful to educators and students.

Group 5

Matrix is the way to go

- Method 1: seller secondary
- Method 2: buyer primary
- Method 3: developer small but critical part of industry
- Reasons:
  - Must focus on required competencies – they dictate the skills workers should have.
  - Applications will be the largest part of the industry in the future
  - As technology becomes more user friendly less skilled people will be doing analysis. Therefore, we must focus on education of K-12 for geospatial concepts as well as higher education for professionals and lifelong learning.

Group 6

- Method 1: 7 unanimous
- Reasons:
  - Job seekers need to choose technical key words for their job searches.
  - Cross listing w/ method 2 would be helpful.
  - Cross referencing among applications
  - Articulating specific needs from developers perspective

Group 7

- Method 1=7; method 2 = 1
- Reasons:
  - Lowest common denominator is technology
  - Unique to geospatial industry – collection of professions
  - More aligned with the definition [of the industry] we drafted

APPENDIX 3—SOC JOB CLASSIFICATION SUGGESTIONS

Group 1
To supplement the top three choices [NEED TO SHOW THESE] add:

- GIS Scientist

Note – Need to decide GIS vs. Geospatial
Note – Growth of the industry might be greatest in other SOC sectors where GIS is a skill set added to your primary self-description of occupation.

Group 2
- REVOLT!
- Aggregate into 4-6 general categories for SOC.
- All of these can fit
    - Ex. GIS or Geospatial - Analyst, Technician, Manager, Progammer/Developer

Group 3
- Geospatial Specialist
- Geospatial
    - Technicians
    - Analysts
    - Manager
    - Systems Developer

Group 4
- Geo-Spatial Professional

  Geospatial….
    - Technicians
    - Managers
        - Data
        - Operations
    - Analysts
        - Data
        - Database
        - Remote Sensing
        - Imaging
    - Integrators
        - Data
        - Systems

Group 5
- Geographer
- Physical Scientist
- Photogrammetrist
- GI "Technologict" (paraprofessional)

Comment – The “shopping list” needs to be consolidated and then segmented by Job Category, Competency and Proficiency

Group 6

- Geospatial Bottlewasher
- Geospatial System Integrator
- Geospatial Data Mining
- Geospatial Data Fusion

GIS <> Geospatial

Group 7

- GIS Database Manager
- GIScientist
- GIS System Architect
- GIS Project Manager

Group 8

- Geospatial Web Integrator
- GPS Data Collector
- GIS/ Geospatial Technician
- GIS/ Geospatial Analyst
- GIS/ Geospatial Media Technician

APPENDIX 4-ROLES AND JOB COMPETENCIES

Table A. Roles and Job Competencies--January 27, 2006
--

ROLE	FREQUENCY	PERCENT
Application Development	39	12.87
Data Analysis	33	10.89
Project Management	33	10.89
Data Management	32	10.56
Visualization	32	10.56
Systems Analysis	30	9.90
Systems Management	26	8.58

Roles receiving most cites as important to jobs in feedback mechanism. See full list in the following Appendix 4. B. Table and additional roles and competencies from January 27 Roundtable group discussions in Appendix 4.C. Table.

APPENDIX 4-ROLES AND JOB COMPETENCIES

Table B. Twelve roles played by geospatial technology professionals (Gaudet et. al, 2003)

Applications Development	Identify and develop tools and instruments to satisfy customer needs
Data Acquisition	Collect geospatial and related data
Coordination	Interorganizational facilitation and communication
Data Analysis and Interpretation	Process data and extract information to create products, drive conclusions, and inform decision-making reports
Data Management	Catalog, archive, retrieve, and distribute geospatial data
Management	Efficiently and effectively apply the company's mission using financial, technical, and intellectual skills and resources to optimize the end products
Marketing	Identify customer requirements and needs, and effectively communicate those needs and requirements to the organization, as well as promote geospatial solutions
Project Management	Effectively oversee activity requirements to produce the descried outcomes aon tie and within budget
Systems Analysis	Assess requirements to produce the desired outcomes on time and within budget
Systems Management	Integrate resources and develop additional resources to support spatial and temporal user requirements
Training	Analyze, design, and develop instructional and non-instructional interventions to provide transfer of knowledge and evaluation for performance enhancement
Visualization	Render data and information into visual geospatial representations

Table C. Additional Roles and Competencies--January 27, 2006[2]

ROLE	COMPETENCIES
Group 1	
GIS Scientist	Enterprise Applications Management
Geodatabase Designer	Standards/Interoperability
	Clearinghouse/Portals
	Web/Distributed Web Services
	Visual Display
Group 2	
Data Acquisition	Logic
	Mathematics
	Geodesy
	Spatial Problem Solving
	Civics/Government
	Remove subject matter related competencies (ie. Geology, forestry, transportation)
Group 3	
Application/System Developer	Existing List inadequate
	Seriously consider utilizing "GIS + T" Body of Knowledge (www.ucgis.org) to replace existing list
Group 4	
Service Integration	Geodesy
Security	Statistics
QC/QA	Research - Web Research
Web Development	Metadata - Development and Use
	Domain Expertise
	Remove - Environmental, Geology, "Application" from Remote Sensing Application & Technology, "Information Processing" from Spatial Information Processing Analysis
Group 5	

Research & Development	G.I. Applications (pick one or more)
Modeling and Decision Support	Geology
Decision-maker (ie. Chief Decisions/Creative Officer)	Environmental
	Health/EPI
	Legal
	Energy
	Forestry
	Agriculture
	Defense/Intelligence
	Climatology
	Business
	Biology
	Meteorology
	Resource Management
	Oceanography
	Other
	Quantitative Analysis
	Remove the word "Applications" from GIS Theory and Remote Sensing Theory
Group 6	
Executive Management (ie. Geospatial Information Officer)	Temporal Information Processing
	Communication Tools
	Remove – Environmental and Geology Applications
Group 7	
Management	Think spatially
	Database Management
	Geographic Awareness
	System Integration
Group 8	
Data Collection	Database Management

Data Mining	Data Translation
Data Integrator	System Integrator
Product Developer	Cross-Disciplinary Translation
Wireless System Manager	Multi-Media Management
Video Product Developer	Search and Data Dev.
	ADDITIONAL COMPENTENCIES:
	Ability to assess relationships among geospatial technologies
	Cartography
	Computer Programming Skills
	Environmental Applications
	Geology Application
	Geospatial Data Processing Tools
	GIS Theory and Applications
	Photogrammetry
	Remote Sensing Theory and Applications
	Spatial Information Processing
	Technical Writing
	Technological Literacy
	Topography

APPENDIX 5- FACILITATORS' NOTE ON PROCESS

The online feedback mechanism focused on five issues:

1. Defining the geospatial technology industry
2. Geospatial market segmentation
3. Geospatial workforce needs
4. Geospatial workforce competencies
5. Meeting geospatial workforce needs (as identified in 3 and 4)

To achieve these goals, we structured the Second Roundtable around a series of short presentations of the data from the online feedback mechanism related to each of five issues. These presentations (available on the AAG website) provided an overview of the quantitative data from the online feedback mechanism and a summary of the comments for each issue. We followed each presentation with small group discussions during which each group was given a question to respond to based on the data (described below). Each group was asked to post its most important responses or discussion points. These were then the basis for a plenary discussion which looked for areas of common ground across groups and how we might understand that common ground. We also looked for areas of disagreement and how we might understand those disagreements.

Session 1: Defining the geospatial technology industry

Session 1 related to Questions 3 and 4 of the Feedback Mechanism and the first of the five issues. In those questions, respondents were asked to select 1 of 4 commonly used definitions with which they most agree (Q3); and to provide suggestions to improve the definition chosen (Q4). The definition that received the most positive responses states:

> "The geospatial technology industry is 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 the development and life-cycle management of information technology tools to support the above."

Participants were asked to review that definition, and discuss the ideas, principles and concepts from the other definitions might be integrated into it. We also asked them what they would add or remove for the definition to improve it.

Groups of six to eight were given time to do this work and to put their ideas on a large sheet of flip chart paper. The work of each small group work was posted for plenary review and discussion. That discussion focused areas of common ground among the groups, as well as identifying areas of difference. Ideas from that discussion have been incorporated into this report.

Session 2: Geospatial market segmentation

This goal of this session was to refine the categories of segmenting the geospatial market (Questions 5 and 6 of the Feedback Mechanism), responding to the second of the five issues above. Respondents are asked to select 1 of 3 methods to categorize the geospatial/geographic technologies industry (Q5); they are then asked to provide suggestions to improve the categorization method chosen (Q6). After reviewing the data from the feedback mechanism, participants were asked to weigh the two leading approaches in terms of which approach would be most useful to job seekers and employers and to propose the one approach their table feels would be the most useful if only one approach could be used. Each table group was asked to summarize their conversation on a single sheet of flip chart paper which was then posted for plenary discussion. The plenary discussion focused on working through the ideas from the different small groups, clarifying similarities and differences to uncover common ground ideas that might unite or connect the different perspectives.

Session 3: Geospatial workforce needs

The goal of this sessions was to develop a list of job titles most used by those seeking employment and by those seeking employees, drawing questions 7 (whether BLS should update or add new SOCs to reflect the emergence of new or additional geospatial technology professions/jobs) and 8 (list up to 3 job categories to be considered for addition), responding to the third of the five issues above. After summarizing the data from the feedback mechanism, participants were asked to work in their small groups to develop a list of the most important job titles they could agree should be added.

Small group discussion was again followed by plenary discussion of the data from small groups that was posted on flip chart paper around the room. Plenary discussion focused on specific job titles as well why there was and was not agreement on different titles.

Session 4: Geospatial workforce competencies

There were two goals for this session. The first goal was to refine our understanding of in which roles there are and will be shortages of skilled workers over the next 10 years. The session began with a presentation of data from the feedback mechanism on the **roles** (from a list of 12 roles defined by Gaudet et al) for which there are or will be shortages of skilled workers during the next 10 years (Q9). The second goal was to identify additional technical competencies that will be required for the geospatial workforce of the future. Both of these responded to the fourth of the five issues above.

To meet these two goals, participants were asked to address three related questions in their small group discussion:

- How would you revise, modify and improve upon the 8 roles survey participants identified as most important to the industry for the next 10 years?
- What other roles would you add to improve upon this list?
- What other areas would you add to the list of the 13 technical competencies?

As in previous sessions, small group responses to those questions were posted on flip chart paper for plenary discussion.

Session 5: Meeting geospatial workforce needs (as identified in sessions 3 and 4), responding to the fifth of the five issues above.

The goal of Session 5 was to identify additional educational/training mechanisms that are important to the field. Presentation of the data from the feedback mechanism focused on questions 12 in which respondents were asked to identify up to three (3) academic disciplines which will be most important for preparing the geospatial workforce during the next 10 years, and then to identify three (3) most important training/educational programs to the success of his/her organization (Q13). In question 14 they could list additional mechanisms.

Participants were asked to focus their table discussion on whether the results of the feedback mechanisms missed any important educational and training mechanisms. As in each of the earlier sessions, this was followed by a plenary discussion during which participants focused on similarities and differences across the group work.

BIBLIOGRAPHY

Gaudet, Cyndi., Annulis, Helen, and Carr, John (2001). "Workforce Development Models for Geospatial Technology." http://www.geowdc.usm.edu/research/research.htm.

Marble, Duane F., "Defining the Components of the Geospatial Workforce—Who Are We?" ArcNews, Winter, 2006.

Stewart, Mary Ann and Ivan Cheung, "Defining and Communicating Geospatial Technology, Industry Workforce Demand," Winter, 2006

[1] A majority of attendees to the January 27 roundtable supported shortening the first definition and striking "field of practice" from its language. Please see Appendix 1 for examples of other definitions; most definitions were similar to the one provided in the text.

[2] There was near unanimity to strike "Applications" or expand their definition as suggested by Group 5, namely, by grouping roles as:

1) Basic Science and the Science of GIS
2) Management
3) Computer and Web-based Operations
4) Problem Solving as a Part of GIS (e.g. geodesy)