Pathways in Geospatial Post-Secondary Education and Careers:

Education Pathways Project

by

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With contributions from

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New Mexico Geographic Information Council

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"...never stop learning how geospatial data can be used. Push the boundaries of GIS usage today."

Forward

I am pleased to present the culmination of over three years' of discussion and work by the leadership of the New Mexico Geographic Information Council (NMGIC). Education has always been an important topic for the NMGIC Board . In 2013, we discussed having a one-day meeting with a session where educators meet with industry leaders to discuss trends, a session where students meet with industry and government leaders, and a session for student posters and presentations: bring together industry, education, and students to discuss geospatial technology in the present and in the future. We referred to it as "Pathways," as in the pathways people take toward a career in a geospatial field.

While the conference proved to be overly ambitious at this time, it remains a goal, and this document is the first step on our own pathway towards this conference. Amy Ballard, Dr. Joe Zebrowski, and myself gathered to discuss how to move "Pathways" forward. We felt a survey identifying what resources for geospatial education are currently locally available as well as identifying current education and industry trends, would be a good start. Within this document are the results of our survey and our analysis of it. We've also asked for some professionals to provide a little context on how they see the geospatial landscape of New Mexico.

We hope this will be the first of a regular series of reports on geospatial education and industry. We hope to revise it as needed, improving with each update. The document is not intended to be the final word on geospatial education and industry in the state of New Mexico. Our intent is to inform the NMGIC membership about education and industry in their fields. If the document is of benefit outside of NMGIC, all the better. Our hope is the NMGIC membership will find something interesting and useful within this work. Our goal is for this work to inspire people to come together so that we may discuss the Pathways toward great careers in the fields we love.

Warmest Regards,

Leland J. S. Pierce

Former President, NMGIC Board of Directors

Pathways Project Co-Chair

Acknowledgements

NMGIC Board, Gathen Garcia, Ginny Seamster, Su Zhang, Rick Koehler, and all who took the time to respond to our survey.

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Introduction

The Geospatial industry has been thriving in New Mexico since at least the early 1990s but has seen major changes over that time. As the demand for employees with geospatial skills increased along with the variety of different kinds of tasks that these employees needed to master, training programs evolved to fill the need. This document presents the result of a survey designed to create a baseline of the current state of New Mexico's Geospatial Industry and related education programs. We hope that this document will be useful for both educators seeking to build relevant curriculum and anyone seeking basic information about the industry as it currently stands.

As those of us who have been in the geospatial industry know, there are a number of factors that make our profession somewhat complicated in terms of education and training. First, our skills can be applied across an extremely broad spectrum of industries. From an educational perspective, this means that geospatial training might occur within an academic program, such as Geography, Urban Planning, or Anthropology; or it could occur separately as a stand-alone certificate from a school or other organization. Second, Geospatial does not mean GIS only. The range of skills encompassed by geospatial includes software-based tasks, but can also encompass photogrammetry, surveying and other extremely demanding, quantitative fields. This makes it difficult know what should be included in a program. Finally, we, as an industry have not settled on a widely-accepted nomenclature for what we teach. Programs can be variously identified as Geospatial, Geographic Information Technology, Geomatics, GIScience, etc.

There have been various national level efforts to address geospatial curriculum in terms of what should be offered by academic programs. The first, known as the Geospatial Science and Technology (GIST) Body of Knowledge (University Consortium for Geographic Information Science, 2006) was published in 2006 and sought to establish model curriculum for Geospatial programs. It included recommended competencies for Geospatial professionals and detailed curriculum recommendations. Another, similar effort was undertaken by the GeoTech Center Consortium beginning around 2008. This NSF-funded Center included faculty from community college Geospatial programs across the country as Co-PI's, including from Central New Mexico Community College in Albuquerque. The results of this effort include model Geospatial programs and curricula, which can be downloaded and adopted for use by faculty (see http://www.geotechcenter.org/). The extent to which the Body of Knowledge and/or GeoTech curricula have been adopted is not clear at this time. Notably absent from this report is any discussion of K-12 geospatial education. We hope to address this important topic in future reports.

I. New Mexico Post-Secondary Geospatial Academic Programs

The range of geospatial training and education options includes individual courses, certificates, associates, bachelor's and master's degrees, offered by two and four year colleges and universities. This section of the report attempts to compile a list of all available programs. The overall documentation effort is complicated by the fact that curriculum is less a permanent fixture than a dynamic system, with regular changes to certificates, degrees and courses. This listing is meant to capture the current state of programs as we currently know them.

School	Program	Degree or Cert
Central New Mexico Community College	Geographic Information Technology	A.A.S.
Central New Mexico Community College	Geographic Information Technology	Certificate
Central New Mexico Community College	Surveying Engineering	A.S.
New Mexico Highlands University	Geographic Information Systems	Undergraduate Minor
New Mexico Highlands University	Geographic Information Systems	Undergraduate Certificate
New Mexico Highlands University	Geographic Information Systems	Graduate Certificate
University of New Mexico Continuing Ed	Geographic Information Systems (GIS) Certificate for Managers	Certificate
University of New Mexico Continuing Ed	Geographic Information Systems (GIS) Certificate for Users	Certificate
University of New Mexico	Graduate Minor in Geographic Information Science	Graduate Minor
University of New Mexico	Undergraduate Minor in Geographic Information Science (GIScience)	Undergraduate Minor
Navajo Technical University	Geographic Information Technology	Certificate
Navajo Technical University	Geographic Information Technology	A.A.S.
New Mexico State University	Geographic Information Science and Technology	Undergraduate Minor
New Mexico State University	Geographic Information Science and Technology	Graduate Minor
New Mexico Tech	Geographic Information Systems	none
Eastern New Mexico University	Geographic Information Systems	none
Western New Mexico University	Geographic Information Systems	none
Southwestern Indian Polytechnic Institute	Geographic Information Systems	Certificate, A.A.S.

Table 1. Academic Geospatial Programs at New Mexico Colleges and Universities

II. The Survey

The Pathways survey was designed to collect information that would be helpful for those engaged in educating the State's Geospatial workforce, from representatives of the New Mexico Geospatial industry. It includes 18 questions and was administered using an online tool. The survey was available for respondents to take between April and June, 2015. We received a total of 31 responses from representatives of government (Local, County, State and Federal), commercial, education, and non-profit organizations ranging in size from sole proprietorships to large agencies. Based on the above, we feel that the survey adequately represents the range of geospatial employers in the state. This section presents the data and analysis of the survey questions.

Characteristics of Survey Respondents

The Albuquerque/Rio Rancho area provided the most responses with 16, Santa Fe next with 9. Responses were also received from Aztec, Belen, Clovis, Las Vegas and Los Alamos. Some respondents had offices outside of New Mexico, such as Rockville, MD, San Francisco, CA, and Tampa, FL. The map below provides a graphic display of the information collected.

"...there is really no substitute for using the software and learning by doing, and even more importantly, learning by making mistakes and asking questions of your instructor and your peers."

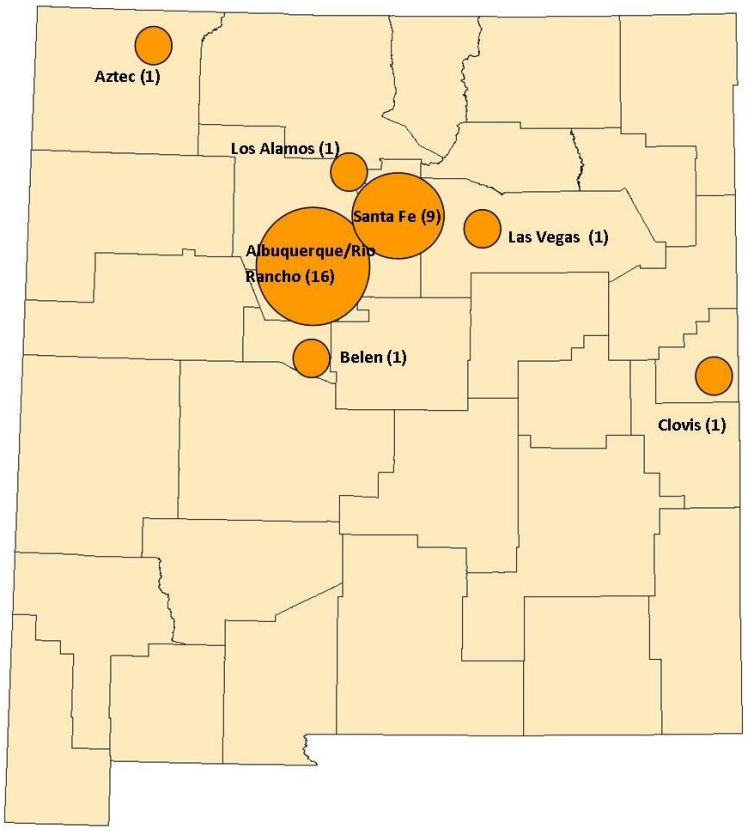


Figure 1. Map showing geographic distribution of respondents

Respondents were asked to specify whether their organization is best described as a government, commercial, education or non-profit entity. Results, shown below in Figure 2, reveal that Government and Commercial sectors dominated our sample. Overall, the sample includes fourteen government, eleven commercial, four academic and 1 non-profit organization.

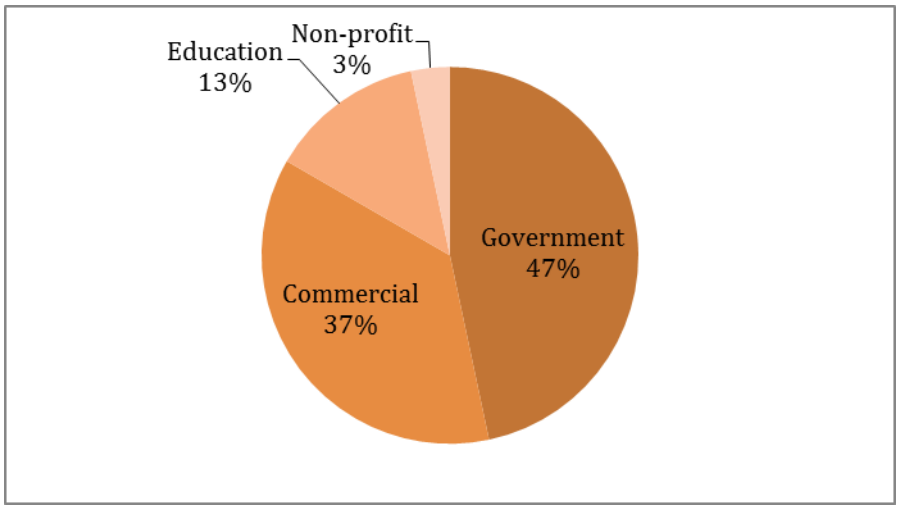


Figure 2. Types of Institutions represented in sample.

Professional Profile: Gathen Garcia, PNM

Background: I began my career more than 3 decades ago in the Civil and Map drafting industry as a manual drafter. All through high school, I studied mechanical and architectural drafting and was exposed to one of the first computer-aided drafting systems that were held at Sandia National labs. After graduating from West Mesa High School in 1975 I took a job as an apprentice in a print shop as a type setter and offset printer.

Two years later I registered at the Albuquerque Technical Vocational Institute (now CNM) in the Civil and Map drafting program which included courses in drafting and surveying. Surveying classes included boundary and Land Survey maps. This is where I was first exposed to cartography and map making hand scribing contour maps and creating documents from information gathered in the field. While attending TV-I, I worked for a local company surveying for mineral claims and drafting, even got to survey an underground mine

in Grants, NM. I also worked for a local engineering firm surveying and drafting new subdivisions in the Albuquerque area. From there I worked for the City of Albuquerque City Engineers office as a civil drafter.

Then in January of 1981, I was hired by PNM for a drafting position. In 1983 I began using AutoCAD version 2.3 for design and drafting. In 1990, I was promoted to Drafting and Records supervisor, implemented the first AutoCAD network for PNM and began supporting engineering staff on networked PC's. Then in 1995 while looking to improve transmission line inspections we began using ArcMap 3.2 which led to the development of a GIS application for Transmission Asset Maintenance Inspection System (TAMIS). Also began the development of an AutoCAD application 3d Design Automated Station Layout (3D-DASL) for the design of 3d substation and switching stations, I hold patents for both applications, and both these applications are still being used today.

I continue to teach AutoCAD and SketchUP courses, begin through advanced, for the University of New Mexico Continuing Education Division. This is my 25th year teaching AutoCAD for UNMDE.

Current Status: Today, I'm the Drafting & Geographic Information Systems Manager for PNM, I'm responsible for planning, directing and managing staff and the activities of the Department's GIS/CAD/3D Visualization, including the development and management of the annual performance budget. Lead, facilitate and build consensus on long range technology direction associated with the vision of GIS/CAD and its integration with other Department-wide business systems application strategies to meet the Department's strategic goals and objectives; work closely with senior level management and other representatives to build an integrated organization-wide view of GIS/CAD initiatives, projects, and resources; and periodically updates the GIS/CAD strategic plan while maintaining consistency with the Department's overall strategic technology plan.

"…with planning between the training institutions and the private sector…barriers could be overcome."

Opinion on Job Market: In my opinion available geospatial jobs in New Mexico are still somewhat limited, but are getting better. Some of this is largely due to economics' with New Mexico being ranked 44th per capita income. Some counties seeing the potential of geospatial technologies are not able to afford building these departments and/or groups. Educating existing companies about geospatial and the benefits it can bring is certainly a good start. Private sector working with state and county agencies to help develop/sharing geospatial expertise with their GIS groups. Become involved with NMGIC and GAC.

Opinion on Training: My opinion on available training in New Mexico in the various geospatial professions is limited to ……not having shareable data available from the private sector for students to work with. In the electric industry for example some data sets are not shared for security and proprietary reason. However with

planning between the training institutions and the private sector these barriers could be overcome. The training being held is at a high level and does not prepare students for advancement careers in the industry.

Students need to be exposed how GIS is used in an enterprise and not just within a given department. An enterprise GIS improves organization workflows since it applies a geographic approach to relate legacy and new information for better decision making; greater efficiency with money, time, and resources; and more effective communication across the corporation. GIS integrates hardware, software, and data for managing, capturing, and displaying all forms of geographically referenced information.

The enterprise GIS framework has the following characteristics; Scalable, extensible, reliable, and secure, open, interoperable, and standards based, capable of being effectively integrated within the enterprise. May be complex to implement; requires significant planning and support; delivers a high return on investment.

Advice for Students: My advice to students is to never stop learning how geospatial data can be used. Push the boundaries of GIS usage today.

- Data management - Enterprise GIS data management focuses on the efficient storage and retrieval of all the organization's relevant geographic information.
- Visualization - The visualization of information in a geographic context provides an intuitive means for accurate and rapid decision making. Visualization is the most obvious demonstration of enterprise GIS. Enterprise GIS will also exploit visualization capabilities by incorporating them into tasks and activities not traditionally associated with GIS.
- Spatial analysis - The wealth of geographic information in our organization is the goal of spatial analysis for the enterprise. It is this capability that nontraditional users of GIS will most greatly benefit from.
- Always ask the question what if?

Advice for Teachers: The advice I would give teachers and instructors is to providing a good foundation of current GIS efforts which are diverse and include: creation of map products, spatial analyses, database queries, records management, and ad hoc information retrieval.

“Sometimes the student is the teacher and provides us an opportunity to step-outside our own comfort zone.”

Be willing to share your practical experiences with the GIS technology and profession. Listen to your student’s questions as they can provide insight to problems we have yet to figure out. Sometimes the student is the teacher and provides us an opportunity to step-outside our own comfort zone. At the beginning of any new class, let students know there may be some questions you cannot answer, but will work to find an answer/ solution to their question.

It's ok to step outside the class syllabus, this is only a guide for the class, both student and teacher benefit from doing this.

Advice for Employers: An Enterprise GIS Organization needs to provide direction using a common infrastructure for building and deploying GIS solutions; Extending geospatial capabilities to an enterprise community ,improving capabilities of other enterprise systems by leveraging the value of geographic information. Focus on organization-wide business needs strategic goals and long-term focus. To develop, manage and distribute authoritative GIS information critical to supporting reliable service to your customers.

III. The Nature of Geospatial Work in New Mexico

The survey included questions requesting respondents to reflect on the nature of the geospatial work that their organization performs, both by primary field of interest, broad activity category and specific task. The information on tasks is invaluable for geospatial educators. While not as in-depth as a formal DACUM (Developing a Curriculum) process, the insights that can be gained from our sample may lead geospatial educators to reflect on their curriculum in light of industry needs.

The array of industry sectors represented in the sample is shown in Figure 3., showing a preponderance of Natural Resource related employers. Delving into the specific work being performed, the survey asked respondents to pick from the list of task categories, choosing all that they engaged in. Figure 4. shows the results of this question, showing 87% of employers engaged in data collection of some sort.

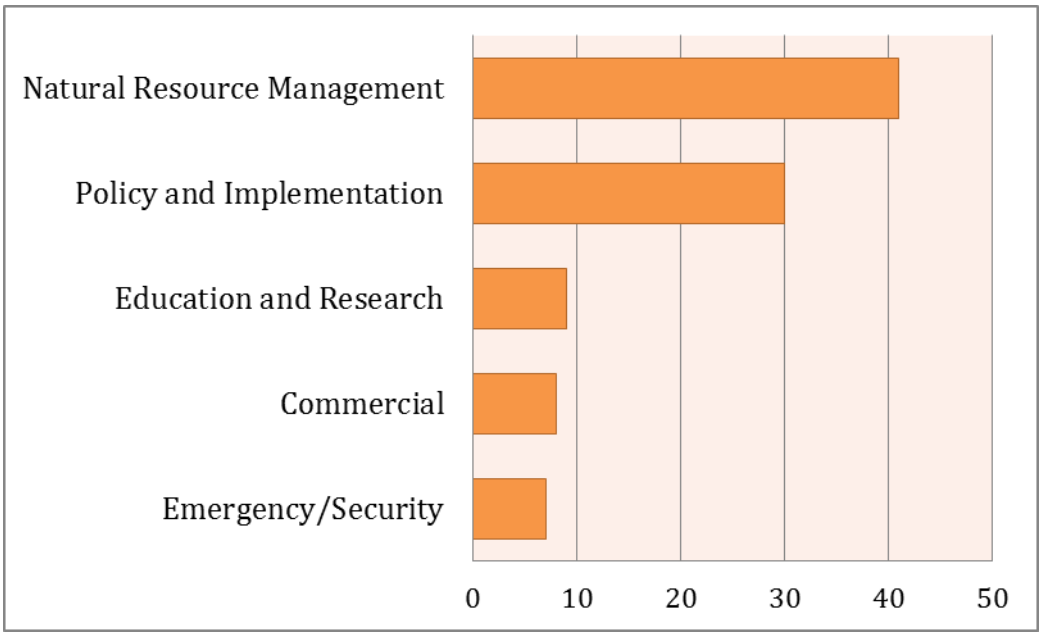


Figure 3. Industries Represented in the Sample

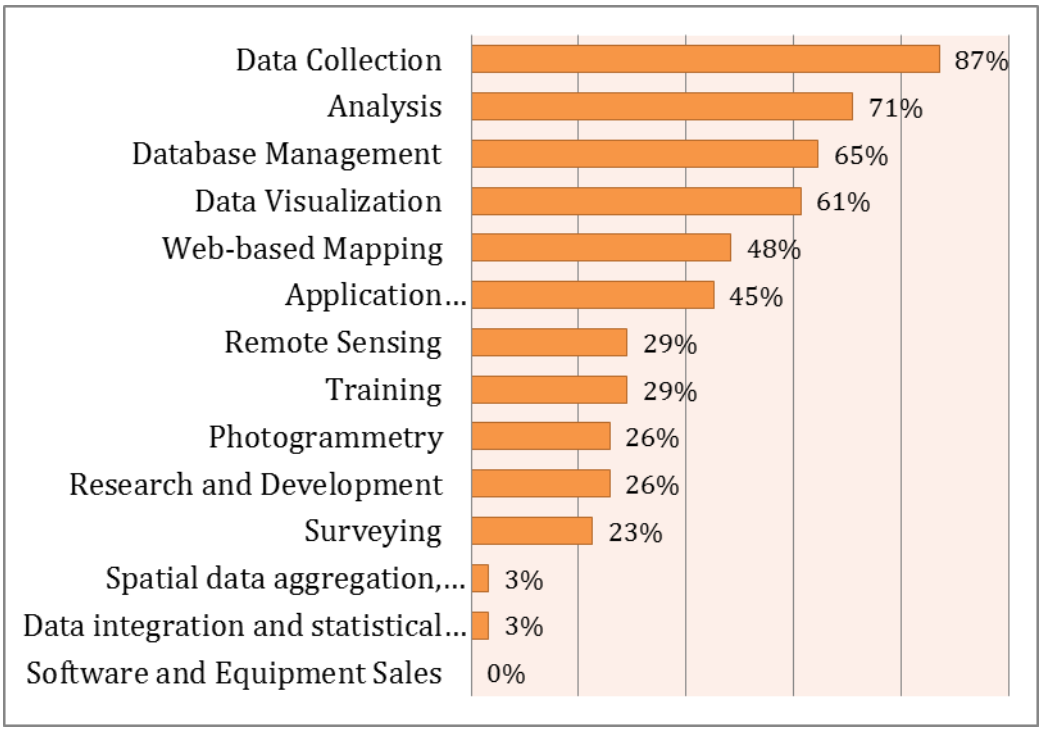


Figure 4. Categories of Geospatial Work Being Performed

The survey also collected data on more specific types of tasks being carried out by New Mexico's geospatial workforce. Respondents were asked to rank tasks in order frequency with which they were performed. Twelve specific tasks were identified, and respondents were also given the option of an open-ended response to describe other tasks. Only 5 respondents entered a task in the "other" category, suggesting that the tasks presented by the survey accurately reflected the nature of geospatial work in New Mexico. The tasks include head's up digitizing, downloading data from the Internet, building databases, creating applications for clients, creating visualizations for clients, creating hardcopy maps, field-based data collection, analyzing multi-spectral imagery, analyzing digital imagery, performing geospatial analysis, providing training, and presenting the results of geospatial analysis. "Other" tasks included data integration and statistical analysis; converting older legacy data and formats; data aggregation, integration and standardization; creating instructional materials; and customer support for hardware or software.

Respondents were asked to rank these tasks from 1-12 in terms of frequency with which they are performed, with 1 being most frequent and 12 least frequent. Therefore, each respondent would rank every task. While not straightforward to interpret, one way to think about this question is to examine which tasks were most frequently identified as more common (receiving a lower number in the ranks). To do this, first a mean value was generated for each task. Tasks with a lower mean value were ranked as more frequent that those with a higher mean. The results are presented in the Table 2.

Table 2. Task Frequency Ratings

Task	Mean Value	Number of 1, 2 or 3 Responses
Building Geodatabases or other GIS databases	4.41	13
Creating hardcopy maps	4.97	12
Creating digital visualizations for clients	5.28	10
Performing geospatial analysis	5.28	12
Field-based data collection	5.31	14
Downloading and processing data from the Internet	6.03	8
Creating applications for clients	6.97	9
Presenting results of geospatial analysis	7.03	6
Providing training for clients	7.97	5
Analyzing digital imagery	8.21	1
Analyzing multispectral imagery	10.03	0

Clearly, developing Geodatabases and other databases is a crucial skill for our geospatial students. Somewhat surprisingly, the creation of hardcopy maps also ranks very high. Though having a lower

mean than some other tasks, more respondents indicated that field-based data collection is their primary task than any other task in the survey.

IV. Getting the Work Done: Software, Hardware and Equipment

In addition to the specific tasks performed by geospatial employees, information about the tools used to complete this work are crucial for geospatial educators to understand, in order to make informed decisions about purchases. Hardware, software and equipment costs are second only to faculty salaries in terms of overall programs costs, so aligning industry and education in this area is extremely important. Though many geospatial and other skills translate to the workplace regardless of specific brands, in many cases students can gain an advantage by already having knowledge of common industry tools.

In terms of broad categories of software used to perform geospatial work, desktop GIS still dominates the landscape (Figure 6.). Web-based GIS is a close second. As far as specific manufacturers go, Esri tops the list (Figure 7.). As Figure 8 shows, proprietary software is widely used by survey respondents, with only 16% of claiming use of open source software at this time.

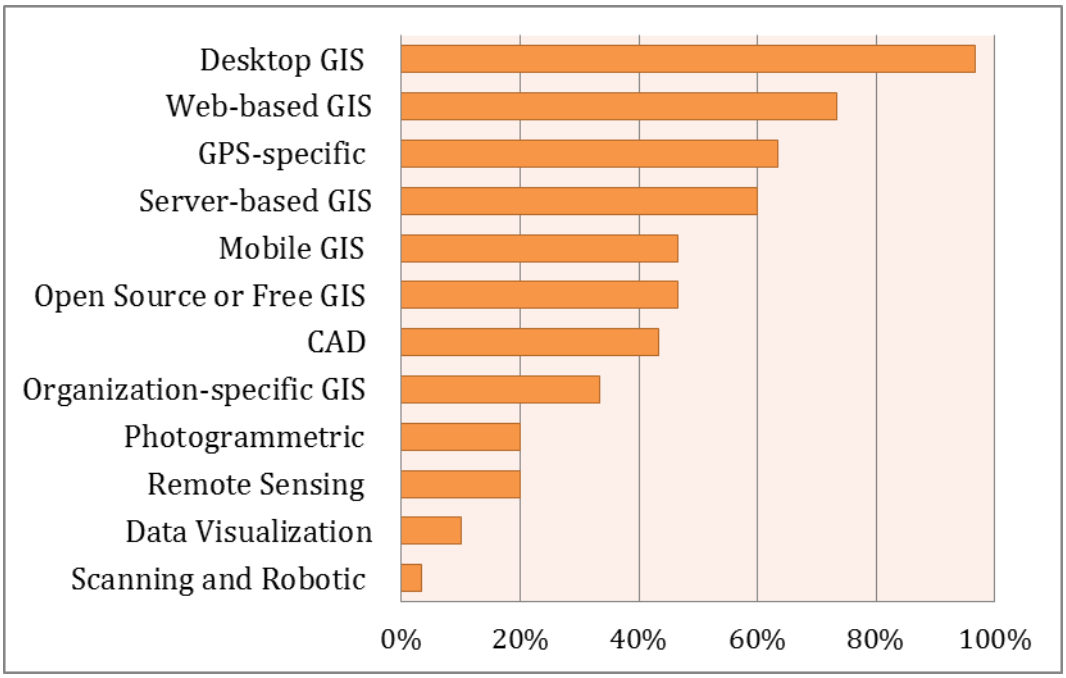
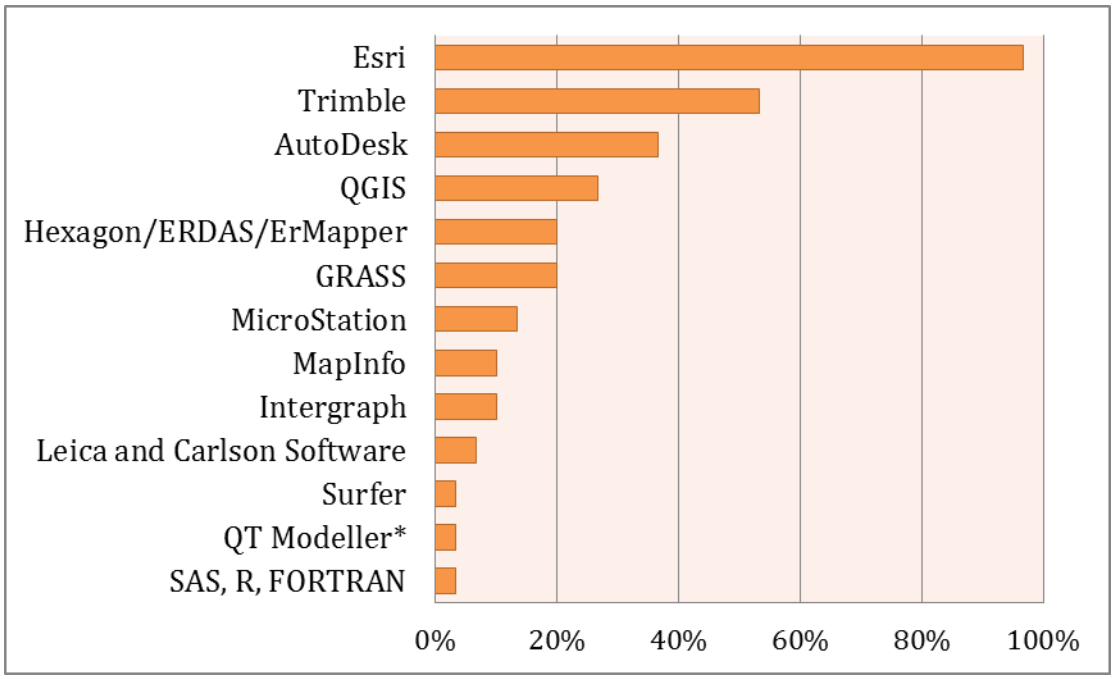


Figure 6. Types of software used to support geospatial projects



*Global Mapper and eCognition also in this category

Figure 7. Brands of geospatial software

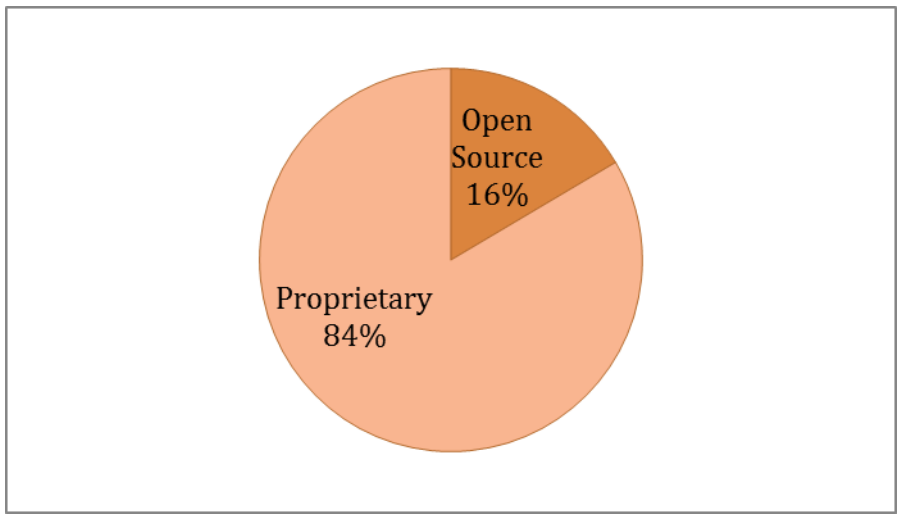


Figure 8. Proprietary vs. open source software use

Equipment, of course, also figures prominently in the geospatial industry, and not surprisingly, all respondents report using desktop computers to accomplish their work (Figure 9).

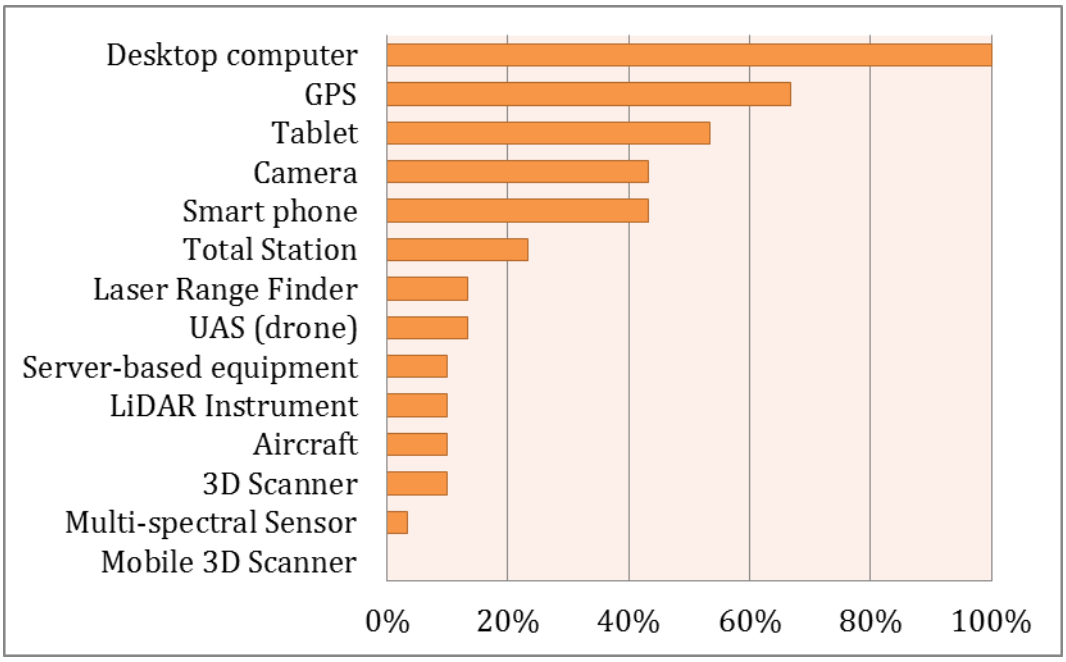


Figure 9. Types of equipment used to support geospatial projects

Professional Profile: Virginia "Ginny" Seamster, NM Dept. Game and Fish

Background: I have a B.S. in Biology and a Ph.D. in Environmental Sciences, both from the University of Virginia. My research in graduate school focused on assessing the impacts of land cover change (grassland to shrubland) on the feeding ecology of the coyote population at the Sevilleta National Wildlife Refuge in central New

Mexico. My first position after graduating with my Ph.D. was working as a GIS Analyst with The Trust for Public Land (TPL). I then obtained a position as a post doctoral researcher at New Mexico State University (NMSU) and worked at NMSU for just over 3 years. I was recently hired by New Mexico Department of Game and Fish (NMDGF) as their BISON-M/Share with Wildlife Coordinator in the Ecological and Environmental Planning Division. I have used geospatial technologies since the fourth year of my undergraduate studies. I took a GIS course that year and applied GIS software for the research project I completed for my undergraduate honor's thesis. I continued using GIS software to make maps and conduct spatial analyses, including development of a land cover map, for my graduate research. I learned a great deal more about cartography during my 7 month tenure with TPL. For my research position with NMSU I extended my GIS skills by developing a web-based map intended to facilitate searching for and obtaining documents generated by or for NMDGF using both text and spatial queries. I also used spatial data and GIS software in a project intended to assess the effect of climate change on the distribution of suitable environmental conditions for 20 terrestrial vertebrate species found in New Mexico, Oklahoma, and Texas.

Current Status: I am new to my current profession but my job entails two primary tasks: database management and contract management for research and other projects related to non-game species of wildlife found in New Mexico. More specifically, I will be working to keep information regarding the biology and ecology of several thousand species found in New Mexico up to date. These data are stored in a web-enabled SQL Server database. Prior to setting up contracts, I will be responsible for organizing a grant proposal review panel and facilitating the process of selecting which proposed projects receive funding through the Share with Wildlife program. There is potential for application of geospatial technology in the process of creating a database of all previously funded Share with Wildlife projects and their locations. There is interest in linking the web-enabled database (the Biota Information System of New Mexico or BISON-M) with other websites that involve web-based maps. BISON-M also provides access to web-based maps of the geographic distributions of many New Mexican species.

"Knowledge of web-based mapping is valuable, if not crucial, given the direction that GIS is heading".

Opinion on Job Market: There appear to be geospatial jobs available with both non-profits and government agencies at multiple levels (city, county, state) in New Mexico. There are fewer positions in academia. The government jobs seem to require higher levels of basic IT skills, including software and network management capability, than the non-profit positions. However, the GIS departments in most New Mexico agencies and non-profits are fairly small. Thus broader experience and knowledge of a diversity of aspects of both the infrastructure and application of GIS technology is beneficial.

Opinion on Training: I am not very familiar with training available in New Mexico regarding the various geospatial professions. The only GIS training I have received while in New Mexico was on the job training from colleagues. Other information I gathered from on-line forums, assistance from ESRI technical support, and trial and error. My understanding is that, in addition to courses provided on campus through the various universities (New Mexico State University, University of New Mexico, and New Mexico Highlands University), New Mexico State University provides some courses through their NM EDGE program. There are also on-line courses available. I only took three courses related to either GIS or remote sensing when I was a student and the University of Virginia did not have a geography department or any kind of emphasis on GIS training. Thus, I would consider the training available in New Mexico to be much more diverse and allow students to gain a more formal training in GIS than anything I was exposed to or aware of during my academic career.

Advice for Students: Depending on the sort of entity you want to work for, I would recommend learning at least one programming language, possibly multiple, and learning about computer networking. Knowledge of web-based mapping is valuable, if not crucial, given the direction that GIS is heading. I didn't really learn anything about web-based mapping in school and I would have benefited greatly from some prior exposure to the basic concepts, terminology, and functionality of web-based maps. Programming skills are useful for almost any GIS application but especially handy if there is an interest in pursuing positions that entail developing web-based maps or mobile phone applications. Mobile phone applications are definitely the wave of the future and so understanding the differences between designing maps for desktop vs. mobile users is valuable. I'd also recommend gaining as much knowledge as possible regarding database structure, design, and metadata. Knowledge of how to use at least one database software, including SQL Server or MS Access, is helpful as is knowledge of programs that can be used in processing spatial datasets, such as R or Matlab. In general I find that people who have the technical skills are more valued than those who know more on the application end. But again, it depends on what kind of position you are going for; if you want to manage a GIS program or go heavily into web-based application design or data analysis, you'll need more technical skills than if you are interested in being a cartographer or applying GIS to environmental compliance or wildlife issues. Different fields also seem to have different platforms that they prefer; climatologists don't seem to use ArcGIS software at all, they use netCDF files and linux systems while ecologists are more likely to use windows and run R and ArcGIS.

Advice for Teachers: I would recommend having students do as many projects, labs and other activities that involve using GIS and related software (e.g., SQL Server; R) as possible. It is important to acquire a basic understanding of the different data types and become familiar with relevant terminology. But there is really no substitute for using the software and learning by doing, and even more importantly, learning by making mistakes and asking questions of your instructor and your peers. There is rarely a single correct way of performing a geospatial analysis; there are often multiple pathways to the same product. Students learn more about the tools that are available, their functionality, and potential problems that they can run into by trial and error than they ever could listening to presentations in a classroom.

Advice for Employers: The ability to interact with other GIS professionals, and possibly more importantly, IT professionals is something that I've found to be very helpful in my career. There were several aspects of projects I've worked on that would not have been possible or would have been done very differently if I hadn't had access to individuals with good programming and other IT skills. If it's possible to have more than one GIS person, or to allow for or even encourage interaction between your GIS and IT departments, that should smooth the way for your GIS professionals and enable them to accomplish more than they otherwise could. The ability to attend local meetings (such as those hosted by NMGIC and the NM GAC) as well as national conferences (such as the ESRI user conference) is also crucial in staying up to date. Geospatial technology evolves rapidly and it is important to be able to stay on top of the latest developments. Interactions with peers greatly facilitate this.

V. Education for the Geospatial Workforce

While education and training are important, the ability for students to find employment in the geospatial field after graduating from an academic program is the bottom line for many educational institutions in the State. Many of the survey questions were designed to characterize New Mexico's geospatial workforce in terms of its composition and requirements for entry. Organizations represented in the sample are primarily small, with 1-5 employees (Figure 5). The industry lacks a major employer, such as an Intel, which can make it a harder sell for students looking for a clear employment path.

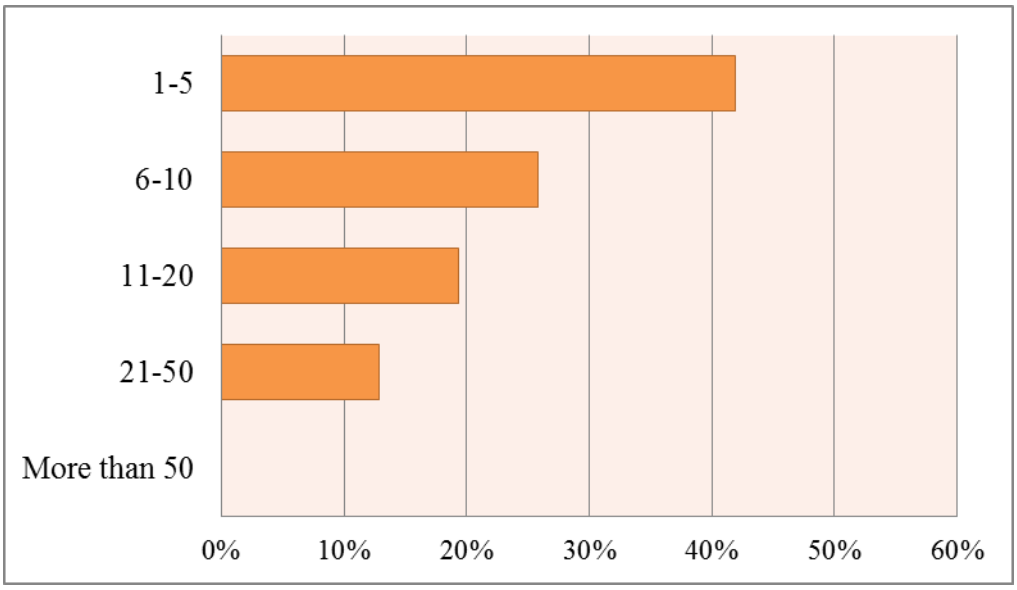


Figure 5. Employees actively engaged in geospatial work at your organization in New Mexico

In terms of the education and training that employers are seeking for entry-level employees, there are some interesting dynamics that appear in the data. Employers are most frequently hiring students with a bachelor's degree in any field, followed closely by students with a 2-year certificate or high school diploma (Figure 10). Students with a bachelor's degree in a geospatial field follow. Of course it is not possible to see from this question what types of jobs are being offered to students within the various categories, which would be an important piece of data to have. The lack of employer interest in 2-year geospatial degrees is somewhat surprising, though for the most part these programs could be seen as pipelines into 4-year degree programs.

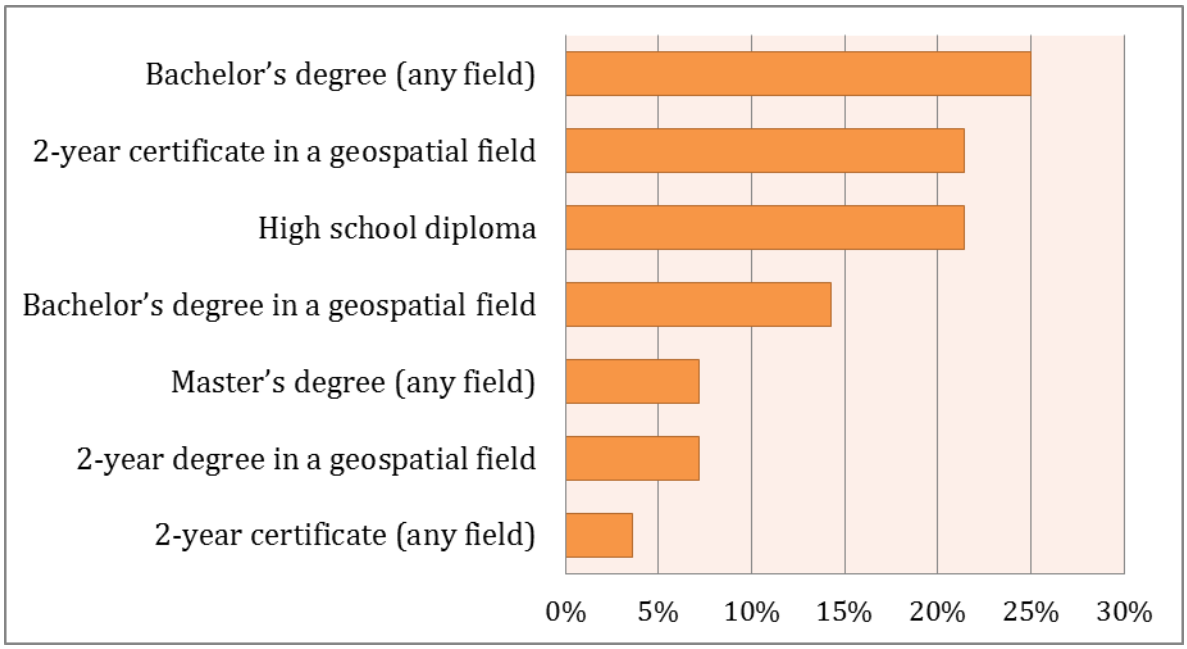


Figure 10. Minimum education level required for entry-level employees

Regardless of education level or type, employers realize that they will be engaged with employee training at some level. As Figure 11 shows, most employers who responded to the survey are interested in employees with basic geospatial skills. This does not comport perfectly with the previous question, which revealed that a high school diploma was the minimum acceptable level for potential employees.

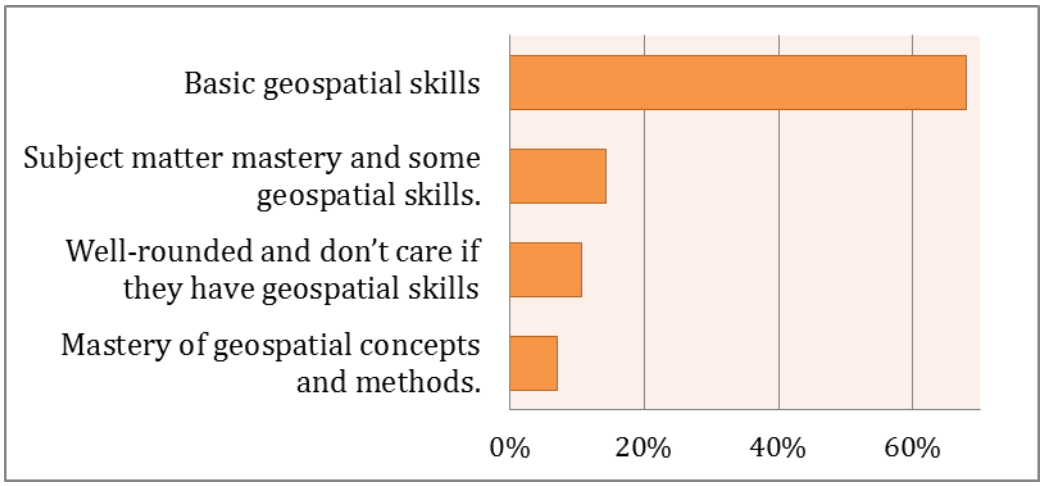


Figure 11. Training entry-level geospatial employees

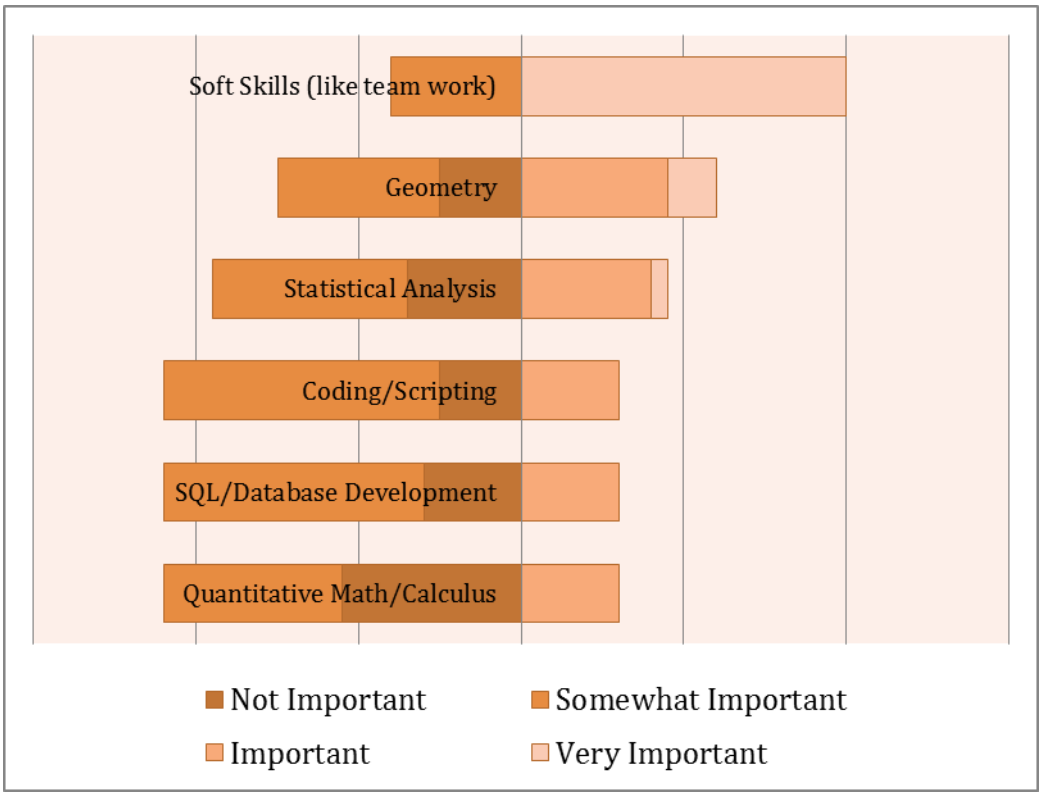


Figure 12. Desirable skills for entry-level geospatial employees

It is clear that employers are looking for employees with basic geospatial skills, but what other specific skills do they value? By a wide margin, employers surveyed responded that soft skills such as ability to work with a team, showing up on time, etc. were very important in potential employees. Working with educators to make sure that these skills are being taught would be an important are for future work. The only other skills identified as very important were geometry and statistical analysis.

When seeking geospatial employees, employers use a number of different approaches (Figure 12). The Internet and other media outlets dominate the survey responses. Since many of the respondents are government entities, the use of government hiring processes figures prominently. A trend also suggested by the responses is the retraining of existing employees to do geospatial work.

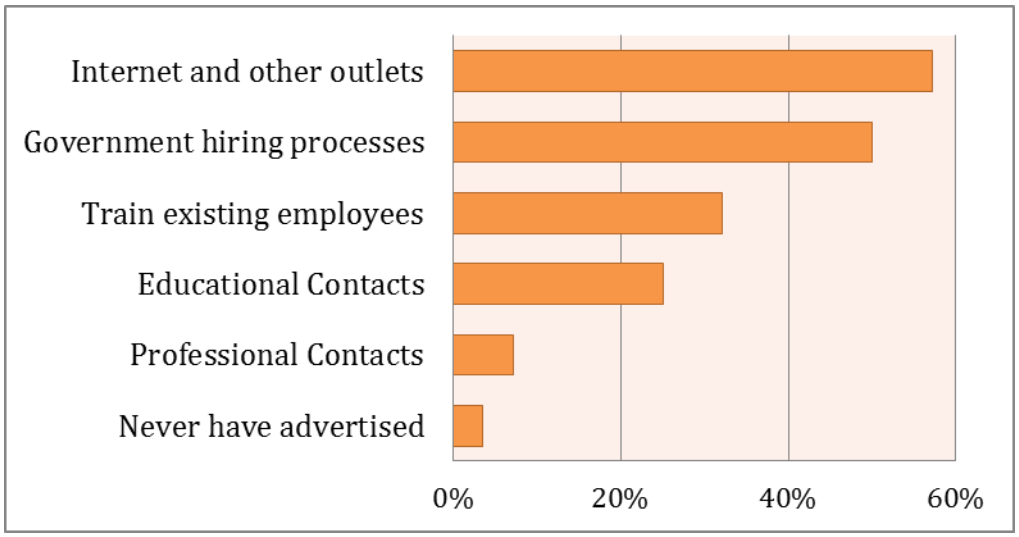


Figure 12. Finding geospatial employees

The employment outlook for geospatial employees as reflected by the survey is mediocre. Though the news is good for existing employees, only 18% of employers reported that they would be hiring at least one new employee this year.

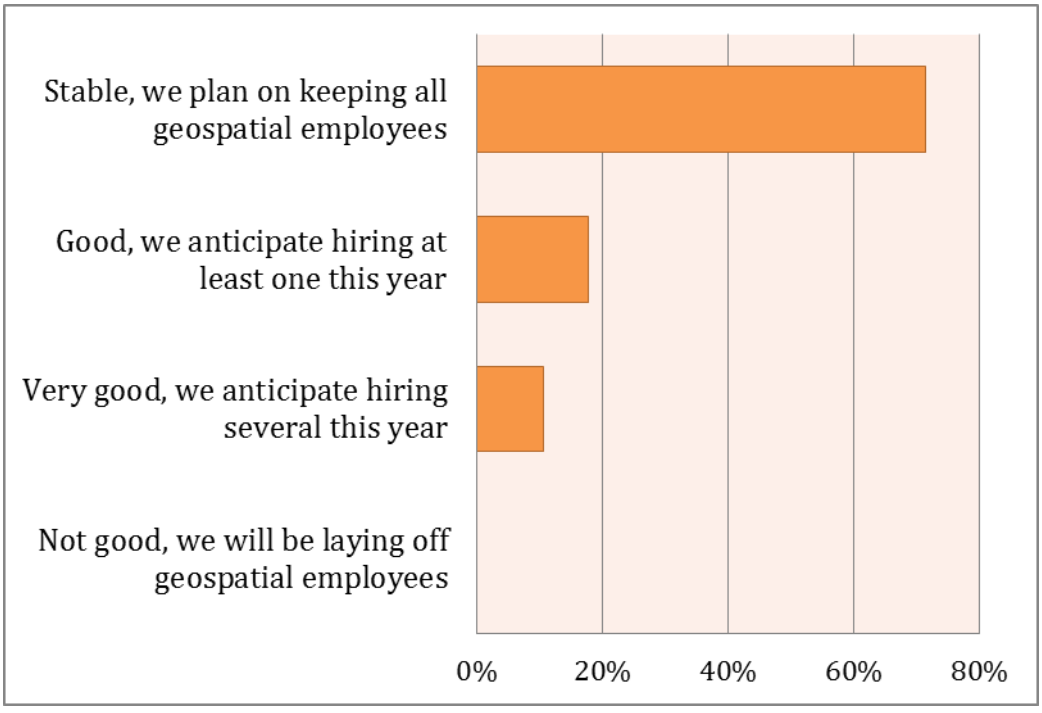


Figure 13. Employment outlook

Finally, the survey asked how industry respondents interact with geospatial educators and educational institutions. Sixty percent of respondents said that they have internship programs available to students. Clearly there needs to be more communication between industry and educators about these opportunities and how they are advertised. Many respondents sit on an educational advisory committee. Improving and increasing opportunities for academic and industry interaction should be a high priority for the future.

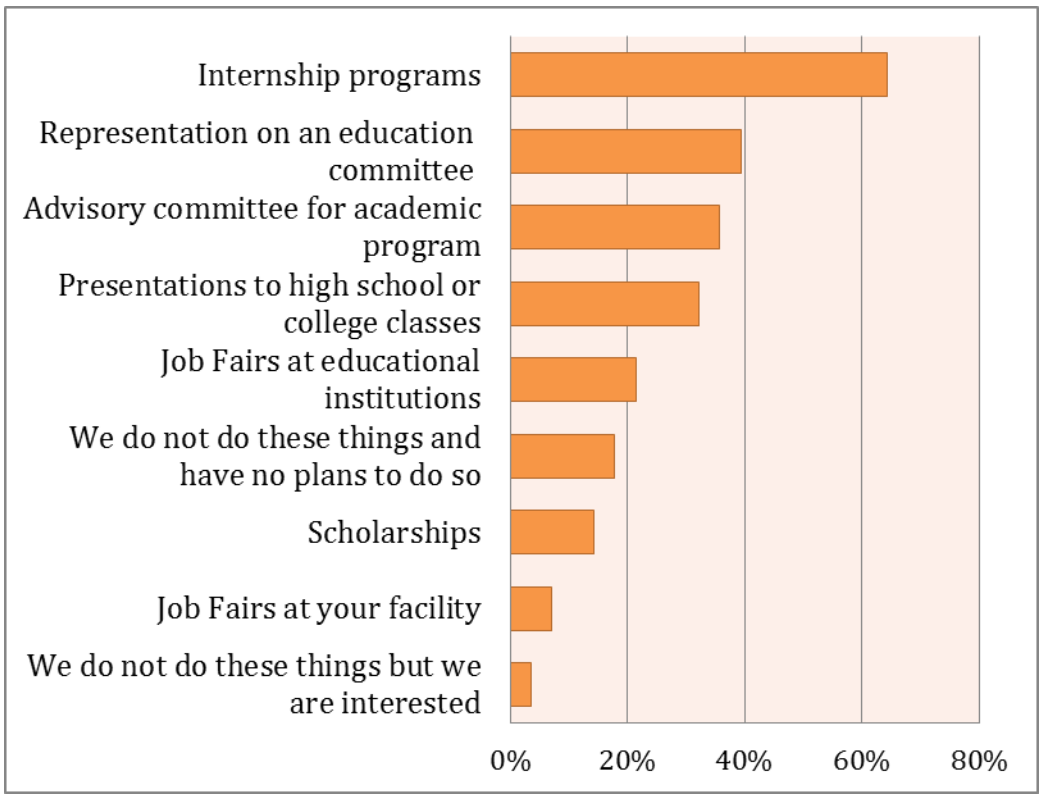


Figure 14. Education/Industry Interactions

Professional Profile: Su Zhang, University of New Mexico

Background: I am a Ph.D. Candidate in the Department of Civil Engineering at The University of New Mexico (UNM) and a Master's student in the Department of Geography and Environmental Studies at UNM, concurrently. I selected my respective concentrations of Civil Engineering and Geographic Information Sciences (GIS) to further my goal of leveraging GIS and Remote Sensing Technology (GIT) for infrastructure management.

While completing my Master's Degree in Construction Management, I researched the application of GIT in construction cost estimation. With the aid of GIT, I developed and validated several new location factor adjustment methods and then identified those that could greatly improve the accuracy of conceptual construction cost estimation. These collective research results have been published in the Journal of Construction Engineering and Management. Since then, I have been completely engrossed in my studies of geospatial knowledge and techniques, and have made a decision to pursue a second Master's Degree in GIS.

During my graduate studies, I found courses pertaining to GIS and Remote Sensing most interesting. These courses on photogrammetric engineering and remote sensing image processing ignited my passion for studying the application of geospatial techniques in infrastructure condition assessment, specifically in roadway pavement surface distress assessment. Traditionally, pavement surface condition assessment is performed with "boots on the ground" by having engineers visually inspect the condition of the pavement surfaces. This approach is time-consuming, expensive, subjective, and potentially dangerous to inspectors. I proposed several methods of using GIT to evaluate pavement surface conditions in a more rapid, cost-effective, rapid, and safer manner. This research is very challenging, requiring obtaining hyper-spatial resolution images and applying advanced image processing techniques to automate the identification and quantification of distresses (e.g. cracks) on pavement surfaces. However, this research is also the most rewarding one because the results will greatly improve the geospatial intelligence capability of infrastructure management agencies.

"I suggest that employers provide more internship opportunities to fresh graduates or students to start developing their skills earlier".

Current Status: Currently I am still a student at UNM. As aforementioned, my goal is to leverage GIS and Remote Sensing Technology (GIT) for infrastructure management. Therefore, I want to apply a position that applies GIT for infrastructure management. It could be some companies that traditionally specializing in civil engineering but currently exploring the geospatial fields, such as Wilson & Company and Bohannan Houston.

Opinion on Job Market: In my opinion, there are many available jobs in New Mexico in the various geospatial professions, although it is less when comparing with other states such as Colorado. The strengths that I can see in the state are that we have a lot of research institutions in New Mexico such as Sandia National Lab and Kirtland Air Force Lab that may provide a lot of jobs related to geospatial professions. The weaknesses that I can see in the state are that we do not have a lot of openings in recent years, which cannot provide enough positions to fresh graduates. They need to go to other states such as Colorado to start their geospatial careers. I think it is a good idea to initiate a statewide geospatial internship program to help fresh graduates to get training and experience to start their career.

"...students should smartly use their time to learn as much as can while they are in school. The more you do, the more you learn. This is the bottom-line."

Opinion on Training: I barely know there is available training in New Mexico in the various geospatial professions. I might be incorrect, but I have never had a chance to get information about the training.

Advice to Students: My suggestion is that students should smartly use their time to learn as much as can while they are in school. The more you do, the more you learn. This is the bottom-line. I have been participated in many different research projects and learn a lot from them. Currently I am completing my Ph.D. degree and I feel confident to start a career in geospatial professions. Another suggestion is that students should join professional organization such as New Mexico Geographic Information Council (NMGIC) or American Society of Photogrammetry and Remote Sensing (ASPRS) to develop their professional network.

Advice to Teachers: There is one really important thing I want to suggest, that is, providing more courses that are related to geospatial professions. Currently we do not have a broad range of options and it is always good to add more courses to the curriculum. In addition, teachers should more actively interact with students to know what they want, what they need.

Advice to Employers: I suggest that employers provide more internship opportunities to fresh graduates or students to start developing their skills earlier. Currently most of jobs require applicants to have several years'

experience in geospatial profession which impeded students to pursue their career. In addition, employers should establish connections with universities and colleges to expose their requirements, which can significantly improve students' skills and make them ready to work.

Conclusions

New Mexico is home to a variety of opportunities for training in the geospatial fields and provides a variety of opportunities for employment as well. Our goal for this document is to energize the members of NMGIC to engage the two aspects to create the best pathways to a geospatial career possible.

A variety of respondents provided information but, as evidenced in Figure 1, we did not receive any responses from the southern parts of the state. Nor did we receive responses from tribal professionals. This document also does not provide information on available geospatial programs at the K-12 level or the programs available to people in New Mexico online. It is our hope that in future surveys we can broaden and expand our responses for a better picture of Pathways in New Mexico. Nevertheless several trends are apparent.

Soft skills are the most desired by employers. The survey suggests the current model is to train people after hiring to excel in a particular geospatial skill set in such as a way as to meet the mission of the company or agency. A high quality candidate for employment should have experience with such skills as public speaking, report writing, and time management.

Given the large amount of public lands in New Mexico and the large number of respondents from the government fields, it was not surprising to find natural resources to be the top industry using geospatial technology. It is likely both natural resources and government will be drivers in the Pathways in New Mexico for many years to come.

Desktop work remains the most commonly used form of geospatial technology in the state with web-based GIS right behind it; in all likelihood those are correlated. The result of low use of non-proprietary or "open" software is intriguing given the long history of NMGIC members making use of such software and may reflect who responded to the survey more than the actual percentage in the state. The result of a high percentage of respondents using esri technology is not unexpected, given the long history of the company in the industry and its strong use by government at all levels. A perspective employee would be wise to be familiar with the products and features of the company.

Employment patterns seem to reflect a non-standard path to being hired in that a variety of degrees training are accepted. Respondents indicated they are generally willing to train employees to get up to speed on the use of geospatial technologies to meet their company missions. In the future would be interesting to see, in the future more respondents from specialized fields like photogrammetry and from salespeople that sell such products as LiDAR and orthophotography, specifically if they would require

more training prior to hiring a new employee. Another employment pattern seen in the survey is that while a few respondents worked in companies with more than 20 people, often as part of a national organization, most shops are small. This, along with the pattern of training after hiring, suggests that employers seek to tailor their geospatial employees to their specific needs, that the employee may work on more than geospatial technology on the job, and that a well-rounded education, including soft skills, is of prime importance. The primary way toward that education-and experience-is currently through internships. Based upon the survey, dialog between employers and educators are on an ad-hoc basis, often through volunteering to be on an academic committee. An additional concern that should be discussed is that not many employers projected growth in their geospatial workforces. Is this a result of concerns over the current economy or has the impact of technologies that make fewer workers able to accomplish the tasks formerly conducted by many keeping growth potential low?

Lastly, data-production, maintenance, and publication-was the primary focus for what the respondents did for a living. This is not a surprise as this is a data-based field and it is our opinion data represents many new opportunities for future employees. For instance, open, big, and smart data are all becoming increasingly important at all levels of society; positions like a data information officer will become more commonplace. How this should be managed in terms of education-under programming or GIS-and where such positions should be placed within a company-position unto itself, or like the current model, adapted to the overall company mission-will be points of discussion the future.

In summary, a well-rounded employee is desired with a variety of skill sets, particularly the soft skills and, in all likelihood, familiarity with web programming and data management. Jobs are out there, as is training, but this is being communicated on an ad-hoc basis. Data efforts like LiDAR and new imagery are creating needs for data management and analysis, and the every-growing use of the web calls for more geospatial employees in fields like broadband and web design. One of the authors heard a talk by an industry leader lamenting that he had the funds to employ a young professional and found many who had the GIS skills for his broadband initiatives but all of them lacked the speaking skills to deal with the public; another young professional was stuck trying to determine if she should be invest more of her training toward geospatial programming or geospatial analysis in order to land a good job. To overcome such problems dialog is needed between employers, educators, and students. It is our hope that this document and future versions of it will encourage NMGIC members to provide opportunities to make that dialog a reality.

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