Workforce Development Models for Geospatial Technology

The University of Southern Mississippi

Cyndi Gaudet
Project Director

Contributing Authors
Heather Annulis
Jon Carr

September, 2001

Funds for this research were provided under NASA/SSC Contract NAS13-98033
Workforce Development Models for Geospatial Technology

EXECUTIVE SUMMARY

The Geospatial Workforce Development Center (GeoWDC) at The University of Southern Mississippi is part of NASA’s effort to develop a well-trained geospatial workforce. The GeoWDC is designed to be a first source of information for geospatial workforce training and development. Results from a recent GeoWDC study include the competencies, work roles, and key deliverables for each role identified in the geospatial information technology industry. Organizations can use the Geospatial Technology Competency Model© to describe the kinds of workers needed in the geospatial information technology industry; improve employee recruitment and selection; manage the performance of existing employees; and design geospatial information technology training and education programs. This report provides a competency model, which identifies the roles, competencies, and outputs for the geospatial technology industry.
# Workforce Development Models for Geospatial Technology

## Table of Contents

Section 1  
*Introduction* ...........................................................................................................1

Section 2  
*Purpose of Study* .................................................................................................2  
*Competency Models* ..............................................................................................3  
*Competency Model Benefits* ..................................................................................3

Section 3  
*Research Methodology* ........................................................................................5  
*Project Phases* .........................................................................................................6

Section 4  
*Research Results* ..................................................................................................9  
*Industry Definition* .................................................................................................10  
*Future Forces* ..........................................................................................................10  
*Ethical Challenges* ..................................................................................................12  
*Geospatial Technology Roles* ................................................................................13  
*Geospatial Technology Outputs* ............................................................................14  
*Geospatial Technology Competencies* ...................................................................18  
*Geospatial Technology Competency Model* ........................................................21  
*Geospatial Technology Model Matrix of Roles and Competencies* .......................22

Section 5  
*Discussion and Conclusion* ..................................................................................24

Section 6  
*References* ............................................................................................................26

Section 7  
*Role Profile Appendix* ..........................................................................................28
The worldwide market for geospatial technologies has enormous market potential. Currently estimated at $5 billion, the market is projected to have annual revenues of $30 billion by 2005 (Remote Sensing market: $20 billion, Geographic Information Services market: $10 billion). In the mapping market alone, worldwide annual revenues for satellite and aerial data products is estimated to increase from $2.2 to $4.2 billion over the next five years. High resolution satellite imagery product revenues are estimated to increase from $1.4 to $3.8 billion in the same period. In the United States, remote sensing industry annual revenues are projected to increase steadily from the 1992 benchmark of $0.75 billion to $4 billion by 2005 (NASA, 2001).

As an emerging growth industry, there is a serious shortfall of professionals and trained specialists who can utilize geospatial technologies in their jobs. The growth of this market demands support of the education, training and development of geospatial professionals and specialists. A strategy is required to meet the challenge of providing a well-trained workforce while at the same time perpetuating an expanding market of persons trained, familiar and ready to apply geospatial technologies when solving workplace and societal challenges.

The National Workforce Development Education and Training Initiative is an effort of the Office of Education and the Earth Science Enterprise, both located at the NASA John C. Stennis Space Center. The initiative is a customer-focused effort to meet workforce demands for the emerging multi-billion dollar geospatial industry and to help the U. S. maintain its global leadership in geospatial technologies.
Workforce Development Models for Geospatial Technology

Purpose of Study

With increased market potential comes an increased need for a systematic approach to developing a workforce to support industry growth. The workforce planning process must be a customer-driven process that determines workforce needs and provides the foundation for appropriate training and education opportunities. This paper presents a competency model that integrates the technical, business, analytical, and interpersonal skills required to develop a workforce for the geospatial technology industry.

Creating a workforce development plan requires an analysis of the work that is required. With the changing nature of jobs and work, the concept of a job is becoming obsolete. In many high technology industries, cross-functional project teams are common and employees shift from project to project throughout the year. Management tasks also change in such situations, for they must serve their project teams as facilitators, gatherers of resources, and removers of roadblocks (Mathis & Jackson, 2000). What has become apparent, given the cross-functional nature of work and the speed with which technology changes work tasks and responsibilities, is a more flexible technique for approaching workforce development.

The basis for recruiting, selecting, and compensating individuals should be based on their competence and skills, not what they do. The best approach to develop a workforce is to focus less on specific tasks and duties and to focus more on identifying work-related competencies. Groups of competencies typically include the knowledge, skills, and abilities required in accomplishing a task or job in a specific work role.

The definition of a competency can also include motives, beliefs, and values (Mirabile, 1997). Competencies have further been described as “behaviors that
distinguish effective performers from ineffective ones” (Dalton, 1997). “For some people, a job’s tasks and activities are competencies. Many job descriptions and approaches are task-oriented, even when the tasks aren’t called competencies (McLagan, 1996).”

**Competency Models**

“A competency model is a set of success factors, often called competencies, that include the key behaviors required for excellent performance in a particular role. Excellent performers on-the-job demonstrate these behaviors much more consistently than average or poor performers. These characteristics include key behaviors that drive excellent performance. These characteristics are generally presented with a definition and key behavioral indicators (Lucia & Lepsinger, 1999).” Pat McLagan (1980) defines competency model as “a decision tool that describes the key capabilities for performing a specific job.”

“The construction of a competency model calls for the correct identification of the critical competencies required for effective performance (Ingalls, 1979).” In order to achieve “correct identification” the designer of the model must conduct extensive research into the company or industry concerned with workforce development. Role experts – individuals who function in specific areas of expertise -- must be interviewed. A common mistake during the design process is that management, without input from role experts, makes decisions about the skills necessary to perform a certain job. “Building a so-called competency model based solely on the beliefs and opinions of a group of people, albeit powerful people, makes it a useless exercise (Dalton, 1997).” The “useless exercise” yields an “ideal”—and often impractical—model rather than a model displaying the expected outcomes. The expected outcomes model based on role expert contributions lends itself to flexibility. The model looks to the future rather than just the present, and the model is not job specific. The nonspecific model can grow and develop with the changing needs of the company or industry.

**Competency Model Benefits**

Competency modeling is an attempt to describe work and jobs in a broader, more comprehensive way (Zemke & Zemke, 2000). Competency-based performance models yield a common language across positions within an industry. It is the best approach when creating a performance management system, and it enables workforce development professionals to identify core capabilities required of any employee in any position across an entire organization or industry (Gilley & Maycunich, 2000). Robinson and Robinson (1996) encourage the use of a
performance model when describing performance expectations for a specific position or job cluster.

Competency models identify the skills, knowledge and characteristics needed to perform a job and have been in use for more than three decades. In the last five years, interest in them and their potential to help staffing and development efforts has increased dramatically. Intensified competition, aggressive cost management, proliferation of 360 degree feedback, downsizing, and emerging technological industries will continue to draw interest to competency model development and use (Lucia & Lepsinger, 1999).

A competency model includes the competencies required for satisfactory or outstanding performance within the context of the worker’s job roles, responsibilities, and relationships, examined both internally and externally (Dubois & Rothwell, 2000). These models help to integrate people with practices while providing a roadmap for employee selection, development, evaluation, work design, pay systems and performance management. Ultimately, competency models result in human energy being channeled in more productive directions to help organizations with emerging concerns such as economic impacts and globalization (McLagan & Suhadolnik, 1989).

In 1983, McLagan and Suhadolnik created a set of competencies that is used as a foundation and framework for Human Resource Development (HRD) professionals. In this study, competencies are defined as “the knowledge and skills which are key to producing the critical outputs of the training and development field and its roles.” They describe characteristics of people, which represent the tools individuals bring to work. Knowing the critical competencies for training and development can help people in and around the field make more effective judgments concerning selection, development, assessment, human resource planning and career planning.

In addition to performance management benefits, results from competency models can be easily translated into training curricula. While training programs based on work-oriented task analysis can become dated as work undergoes dynamic change, training programs based on competency assessment are more flexible and have more durability (Bohlander, Scott & Sherman, 2001).

The competency model approach provides a way to articulate the kinds of workers needed in the geospatial technology industry. Results of this study identify a research-based set of competencies for hiring organizations to use to improve employee recruitment and selection and to create competency-based performance management systems to help professionally develop existing employees in the industry. Finally, the study provides a research framework for training providers and academic institutions to use for creating the most effective and efficient training and education opportunities in this particular industry.
A competency model approach was utilized to help achieve the NASA goal of assisting in the development of a well-trained workforce for the geospatial technology marketplace. In order for a competency model to have meaning and relevance for those who will ultimately use it, geospatial technology industry stakeholders were involved from the beginning to help guide competency model development. The early participation gave members of the geospatial community the opportunity to review the scope of the study, revise role definitions and outputs, and revise preliminary competency menus.

The research design for this study was developed to:

- Produce a competency model for geospatial technology that identifies:
  - work and competency requirements for individuals in various geospatial technology roles
  - standards or quality requirements for geospatial technology work
  - relevant ethical challenges likely to face geospatial technology professionals in their work
- Collect input from a variety of sources, but rely primarily on role experts for each geospatial role and a task force of geospatial experts for information about each role.
## Project Phases

This study was organized into six major phases:

**PHASE 1: Preliminary Geospatial Technology Competency Model**

A review of current literature yielded a preliminary list of geospatial technology roles, competencies and outputs. A task force of geospatial technology experts was identified from stakeholder organizations to review and revise preliminary geospatial technology job requirement information. The result was a revised list of role definitions, outputs and a preliminary list of competencies.

**PHASE 2: Focus Groups**

Two focus group sessions were designed to allow for geospatial expert participation. Both of the focus group sessions were held in New Orleans, Louisiana.

**Focus Group I.** Representatives from trade and professional organizations met in a two-day workshop to define the geospatial industry and determine present and future geospatial information technology workforce needs. Participants identified geospatial information technology work roles and definitions for each role, as well as completed a review of international workforce geospatial industry standards. The following organizations were represented:

- American Society for Photogrammetry and Remote Sensing (ASPRS)
- Environmental Systems Research Institute (ESRI)
- Geospatial Information Technologies Association (GITA)
- Global Initiatives, Inc. (GII)
- Louisiana Department of Environmental Quality (LA DEQ)
- Mississippi State University (MSU)
- Spatial Technologies Industry Association (STIA)
- University Consortium for Geographic Information Science (UCGIS)
- Urban and Regional Information Systems Association (URISA)

**Focus Group II.** In a second focus group, the following government agency representatives met in a separate two-day workshop to discuss workforce needs from their perspective:

- Environmental Protection Agency (EPA)
- Federal Emergency Management Administration (FEMA)
- Global Initiatives, Inc. (GII)
- Pennsylvania Department of Military and Veteran’s Affairs (DMVA)
- U.S. Department of Interior, USGS EROS Data Center
PHASE 3: First Draft Model

NASA SSC’s e-SPACE (electronic-Strategic Planning and Consensus Engagement) Collaboratory was used to improve the effectiveness and efficiency of a final, four-day focus group session. The e-SPACE Collaboratory utilizes GroupSystems, a specialized computer software system designed for use by collaborative work groups that has produced measurable productivity gains for major corporations in recent years. Software designed for electronic meetings, in particular, is documented to reduce by 90 percent the time required for managers to complete complex projects. The strength of using this format is that participants are given the ability to comment anonymously over networked computers, encouraging equal participation by all individuals during the session. The format also provides instant access to information and a structure for decision processes and alternatives evaluation.

This effort helped structure activities for focus group participants considered industry stakeholders and who represent the following organizations:

- American Society for Photogrammetry and Remote Sensing (ASPRS)
- Environmental Systems Research Institute (ESRI)
- Global Initiatives, Inc. (GII)
- Mississippi State University (MSU)
- National State Geographic Information Council (NSGIC)
- Pennsylvania Department of Military and Veteran’s Affairs
- University Consortium for Geographic Information Science (UCGIS)
- U.S. Department of Interior, USGS EROS Data Center
- U.S. Naval Oceanographic Office (NAVO)
- Urban and Regional Information Systems Association (URISA)

PHASE 4: Second Draft Geospatial Technology Competency Model

Role Expert Interviews. After working with industry stakeholders in focus group sessions and after focus group data analysis and interpretation, plans were made to give role experts the opportunity to validate the geospatial roles, competencies, outputs, and quality requirements. Face-to-face interviews were conducted with role experts working in the geospatial industry.

Public and private organizations from more than fifteen major cities across the United States are represented in the study. Employees from over twenty-eight organizations participated in the competency model development. Sixty-seven (56 percent) of the 119 role experts interviewed were from the private sector, and forty-six (39 percent) represented public organizations.
PHASE 5: Final Geospatial Technology Competency Model

Information from role expert interviews was analyzed and yielded the Geospatial Technology Competency Model, which explains the relationship between the roles and competencies required in the industry, a list of outputs and the quality requirements associated with each output by role, and relevant ethical challenges by role for geospatial technology professionals.
The final results of the study are:

- *An Industry Definition* for the geospatial technology profession;
- A list of *future forces* likely to impact future geospatial technology work in the next 3-5 years;
- *Relevant ethical issues* facing individuals in their geospatial technology roles;
- Twelve functional *Geospatial Technology roles* that define areas of geospatial technology work;
- *Key deliverables or outputs* that the geospatial technology workforce must produce or provide to others;
- *Competencies* required to produce geospatial technology outputs;
- *The Geospatial Technology Competency Model*, defining major areas of geospatial technology practice;
- *Role Profiles* for each geospatial technology role that describe the outputs for the role, the quality requirements for each output, the competencies needed to produce the outputs, and the relevant ethical issues facing individuals in each role (Section 7, Role Profile Appendix).
A definition was written during the first two focus group sessions by industry stakeholders to establish a clear industry perspective. Consensus was reached among focus group participants at the third focus group session for the following industry definition:

**Geospatial technology 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 development and life-cycle management of information technology tools to support the above.**

### Future Forces

Using GroupSystems software, a group of geospatial technology experts were given a list of forces that might impact the geospatial industry within the next five years. The list was generated from McLagan’s (1989) identified human resource development forces in a study conducted by the U. S. Department of Labor and the American Society for Training and Development and other research sources. This panel of expert contributors with over 200 years of geospatial technology experience took the revised list and further discussed the list to reach consensus for potential future forces. The following lists the key forces that this study’s expert contributors expect to influence geospatial work and competencies in the next five years:

1. Evolving geospatial information requirements for society.
2. Increased reliance on the use of geospatial information technology for decision-making.
3. Availability and accessibility of geospatial data.
4. Increased pressure and capacity to measure workplace productivity, performance, cost-effectiveness, and efficiency.
5. Increased pressure to demonstrate the value, impact, quality, and practicality of geospatial information technology solutions.
6. Accelerated rate of change and more uncertain work environments.
7. Increased emphasis on customer service and expectation of quality products and services from the workforce.
8. Increased sophistication and variety of tools, technologies, methods, theories, and choices in geospatial information technology.
9. Increased diversity (demographics, values, experience) at all levels of the workforce.
10. Increased expectations for higher levels of judgment and flexibility in worker contribution (specifically, for more creativity, risk-taking, adaptation to change, and teamwork).
11. Increased use of systems approaches that integrate geospatial information technology in the workplace.
12. Business strategies that concentrate more on geospatial information technology services and require strategic geospatial information technology actions.
13. Changed emphasis in organizations from loyalty to merit, accountability, performance, and relevant skills.
14. Globalization of business, increased and expanded international markets, joint ventures, overseas ownerships, and competition.
15. Increased need for commitment, meaningful work, and participation on the job by a larger proportion of the workforce.
16. Increased use of flatter, more flexible organization design, smaller, self-contained work groups; and reduced staff.
17. Increased skill requirements in response to rapid technological change.
18. Increased education and diversity in the U.S. workforce.
20. Change in size and composition of organizations.
21. Revolutionized training through changes in delivery methods.
22. Finding new ways to develop solutions.
23. Increased focus on performance improvement.
24. Proliferating and integrated high performance work systems.
25. Transforming into learning organizations.
27. Continued role of Federal government in developing policies and programs that impact private sector.
Ethical Challenges

Focus group participants developed a list of ethical challenges that role experts were asked to respond to according to the relevance of each ethical challenge to their corresponding geospatial technology role. The following list represents the list of relevant ethical issues for all geospatial technology professionals. For a breakdown of relevant ethical issues by role, see the Role Profile Appendix in Section 7 of this report.

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Recommending solutions appropriate for the customers’ or users’ needs.
5. Pricing or costing products or services fairly.
6. Exercising power or authority judiciously.
7. Making misleading claims regarding return-on-investment.
8. Using client information for personal gain.
9. Falsifying data.
10. Assigning credit appropriately.
11. Making false claims about another’s behaviors or accomplishments.
12. Withholding information or establishing unrealistic expectations.
13. Be objective when examining and verifying the analysis of data.
14. Put in a full day’s work for a full day’s pay.
15. Protecting the integrity of all data.
The following 12 roles define areas of geospatial technology work.

**Applications Development** – Identify and develop tools and instruments to satisfy customer needs.

**Coordination** – Inter-organizational facilitation and communication.

**Data Acquisition** – Collect geospatial and related data.

**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 desired outcomes on time and within budget.

**Systems Analysis** – Assess requirements for system capacities including inputs, outputs, processes, timing and performance, as well as recommend necessary additions or adaptations.

**Systems Management** – Integrate resources and develop additional resources to support spatial and temporal user requirements.

**Training** – Analyze, design, develop instructional and non-instructional interventions to provide transfer of knowledge and evaluation for performance improvement.

**Visualization** – Render data and information into visual geospatial representations.
### Geospatial Technology Outputs

Listed below are products, services, conditions, and information are important to geospatial technology work. A particular job in the geospatial industry may involve responsibility for many of these outputs or only a few. The list should be viewed as a menu of various job elements of geospatial technology work. A listing of outputs by role and the quality requirements associated with each output are shown in the *Role Profile Appendix* in Section 7 of this report.

1. 3D representations
2. A fully functional application that meets customer specification or expectations
3. Acquisition/access requests
4. Advocate alliances with professional organizations
5. Ancillary support
6. Application compliance
7. Application document
8. Application testing
9. Articulation of customer needs to internal technical staff
10. Articulation of customer needs to upper management
11. Assessment of applicable standards
12. Budgets and financial management
13. Cartographic standards compliance
14. Case studies
15. Catalogs
16. Charts/graphs
17. Clearinghouse
18. Communication and information exchange
19. Comprehensive planning
20. Comprehensive policy-making
21. Conceptual design of application necessary to create products specified in requirements
22. Conceptual design of database(s)
23. Conduct liaison activities
24. Configuration control
25. Conflict resolution
26. Contingency plan
27. Contracts or agreements to provide geospatial service
28. Contribution to project review (i.e. PDR, CDR, etc.)
29. Coordinate strategic planning for enterprise and organizations
30. Cost/benefit analysis
31. Data (geospatial and non-geospatial)
32. Data acquisition contract development
33. Data acquisition dictionary
34. Data archives
35. Data backup
36. Data configuration management
37. Data dictionary
38. Data disaster discovery plan
39. Data format transformation
40. Data structure plan
41. Data subsets
42. Data updating
43. Data warehouse
44. Define all appropriate data sources
45. Define data sets and requirements
46. Determination of compliance with contractual requirements
47. Develops and monitors implementation plan
48. Digital maps/charts
49. Distribution system
50. Document data acquisition process
51. Documented solutions to defined problems
52. Dynamic representations/animations
53. Ensure technical implementation meets policy
54. Evaluation and feedback
55. Facilitation of group discussions
56. Facilitation of media-based learning events (such as videotapes, films, audio tapes, teleconferences, computer-assisted instruction)
57. Facilitation of structured learning events (such as case studies, role plays, games, simulations, tests)
58. False color images (pseudo-color)
59. Feedback to learners
60. Fly through/fly over
61. Functional requirements document
62. Geospatial marketing and sales presentations
63. Geospatial sales/business leads
64. Hardware upgrades
65. Hue saturation shaded relief
66. Identify appropriate available instruments and/or create specifications for new instruments
67. Individuals with new knowledge, skill, attitudes
68. Information products to decision-makers for inclusion in the preparation of briefings, reports or other summary presentations
69. Instructional material (such as job aids, instructor guides, workbooks)
70. Interface specification
71. Inter-operability assessment
72. Interpretive products (e.g. maps)
73. Learning environment
74. Linkage to other groups/organizations
75. Management control
76. Management of customer expectations
77. Market research
78. Mathematical transformations (using computer programs to develop
    algorithms, event tables, histograms, etc.)
79. Meeting facilitation
80. Metadata
81. Multi-organizational committee development
82. Organizational training plan
83. Paper maps/charts
84. Participation at conference, symposia, and expositions
85. Partnership development
86. Performance management
87. Plans to market geospatial products congruent with corporate strategic
    plan
88. Policy review
89. Presentation development support
90. Presentations of material
91. Products specifications
92. Project performance monitoring
93. Project protocols
94. Project resources management
95. Project schedule maintenance
96. Project status briefings
97. Project team meetings
98. Promotional and informational material for geospatial products and
    services
99. Recognition of organization/work unit responsibilities
100. Recommendations for database refinements and collection procedures
101. Recommendations for integrating hardware, software, and other
    computer related services for a specific application
102. Report to management on outside issues affecting parent organization
103. Requirements traceability matrix
104. Requirements/scope definition and management
105. Resource acquisition and allocation
106. Risk management
107. Roles and responsibilities document
108. Search and review of existing technical documentation
109. Search, order, and retrieve data
110. Security compliance
111. Security implementation and support
112. Sensor specifications
113. Sensor tasking schedules
114. Software license mechanism
115. Software management
116. Specifications development for hardware and software
117. Staffing recruitment, selection, and assignment of employees
118. Standards
119. Storage management
120. System backups
121. System integration plan development
122. System maintenance
123. Systems budget
124. Systems compliance to specifications
125. Systems performance monitoring
126. Systems support
127. Technology assessment/investigations
128. Temporal and spatial trends
129. Testing and exit criteria
130. Training programs
131. Verify acquired data meets product specification or data content standards
132. Versioning
133. Video production
134. Virtual environment
135. Web page design
136. Web page maintenance
137. Work breakdown structure
138. Work environment
The following list of 39 competencies are the key areas of knowledge and skill that enable individuals to perform geospatial technology work, to produce the outputs or key deliverables for their jobs. The 15 core competencies marked with asterisks are those that are important to at least half of the geospatial technology roles discussed later in this section.

1. **Ability to Assess Relationships Among Geospatial Technologies**: Examining the effects of geospatial technologies on parts of an organization, as well as the effects on the organization’s interactions with customers, suppliers, distributors, and workers.

2. **Ability to see the “Big Picture”**: Identifying trends and patterns that are outside a normal paradigm of the organization sources.

3. **Business Understanding**: Demonstrating awareness of the inner workings of business functions and how business decisions affect financial or non-financial work results.

4. **Buy-in/Advocacy**: Building ownership or support for change among affected individuals, groups, and other stakeholders.

5. **Cartography**: Organizing and communicating geographically related information in either graphic or digital form.

6. **Change Management**: Helping people adapt to the changes brought on by new technologies and helping them to see the value and benefits of new technologies.

7. **Coaching**: Helping individuals recognize and understand personal needs, values, problems, alternatives, and goals.

8. **Communication**: Applying effective verbal, nonverbal and written communication methods to achieve desired results.

9. **Computer Programming Skills**: Being able to understand and use a set vocabulary and grammatical rules for instructing a computer to perform specific task; knowledge of high-level languages; ability to create or revise a program.

10. **Conflict Management**: Helping people work together to resolve disputes through constructive processes and techniques.

11. **Cost Benefit Analysis/ROI**: Understanding the relative costs of each geospatial technology, or combination of geospatial technologies and assuring that the organization is receiving a good value for the dollars spent on these technologies.
| 12. Creative Thinking: Recognizing, exploring, and using a broad range of ideas and practices; thinking logically and creatively without undue influence from personal biases. |
| 14. Ethics Modeling: Modeling exemplary ethical behavior and understanding the implications of this responsibility. |
| 15. Feedback Skills: Communicating information, opinions, observations, and conclusions so that they are understood and can be acted upon. |
| 17. Geospatial Data Processing Tools: Knowing and being able to apply the skills needed to operate currently used geospatial data processing tools. |
| 18. GIS Theory and Applications: Understanding the theory behind GIS and being able to identify and implement modern day applications for it. |
| 19. Group Process Understanding: Understanding how groups function; influencing people so that group, work, and individual needs are addressed. |
| 20. Industry Understanding: Demonstrating awareness of the vision, strategy, goals, and culture of the geospatial technology industry. |
| 21. Knowledge Management: The efforts to systematically find, organize, and make available a company’s intellectual capital and to foster a culture of continuous learning and knowledge sharing so that organizational activities build on existing knowledge. |
| 22. Leadership Skills: Influencing process of leaders and followers to achieve organizational objectives through change. |
| 23. Legal Understanding: Ability to understand legal issues affecting the application of geospatial information technology. |
| 24. Model Building Skills: Conceptualizing and developing theoretical and practical frameworks that describe complex ideas in understandable, usable ways. |
| 25. Organization Understanding: Seeing organizations as dynamic, political, economic, and social systems that have multiple goals; using this larger perspective as a framework for understanding and influencing events and change that can impact implementation and support of geospatial technologies. |
| 26. Performance Analysis and Evaluation: The process of comparing actual and ideal performance in order to identify performance gaps or opportunities. |
27. **Photogrammetry**: Recording, measuring, and plotting electromagnetic radiation data from aerial photographs and remote sensing systems against land features identified in ground control surveys, generally in order to produce planimetric, topographic, and contour maps.

28. **Problem-Solving Skills**: The ability to consider alternative courses of action and select and implement appropriate solutions.

29. **Questioning**: Gathering information from stimulating insight in individuals and groups through use of interview, questionnaires, and other probing methods.

30. **Relationship Building Skills**: Establishing relationships and networks across a broad range of people and groups.

31. **Remote Sensing Theory and Applications**: Understanding the underlying theories related to acquiring an object without contacting it physically such as aerial photography, radar, and satellite imaging.

32. **Research Skill**: Selecting, developing, and using methodologies such as statistical and data collection techniques for formal inquiry.

33. **Self-Knowledge / Self-Management**: Knowing one’s personal values, needs, interests, style, and competencies and being able to manage their effects on others.

34. **Spatial Information Processing**: The process of modeling, examining and interpreting model results necessary for evaluating suitability and capability, for estimating and predicting, and for interpreting and understanding.

35. **Systems Thinking**: Identifying inputs, throughputs, and outputs of a subsystem, system, or suprasystem and apply that information to improve the application of geospatial technologies; realizing the implications of geospatial technology or many parts of an organization, process, or individual; taking steps to address the impact of applying these technologies.

36. **Technical Writing**: The ability to “translate” technical information to nonspecialists.

37. **Technological Literacy**: Understanding and appropriately applying existing, new, or emerging technologies.

38. **Topology**: Understanding how map features represented by points, lines and areas are related, with specific emphasis on the issues of connectivity and adjacency of features.

39. **Visioning**: Seeing the possibilities of “what can be” and inspiring a shared sense of purpose within the organization.
When presented with a list of competencies, role experts were asked to identify the level of importance and the level of expertise required for their work role. Four categories of geospatial technology competencies were identified as the required knowledge, skills, and abilities to function in geospatial technology roles. The four categories of competencies -- technical, business, analytical, and interpersonal -- are shown in Table 1. Core competencies (those critical competencies that cut across all twelve roles) are identified with an asterisk. The following scale was used to rank the importance of competencies: 0-insignificant, 1 – minimal importance, 2 – moderate importance, 3 – somewhat important, 4 – very important, 5 – critical. Competencies identified as required geospatial technology competencies have mean ratings greater than or equal to 3.5 or were rated a 4 by 50 percent or more of the role experts for the role. Figure 1 provides a snapshot of competencies required for each work role.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Geospatial Technology Competency Model©</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical Competencies</strong></td>
<td><strong>Business Competencies</strong></td>
</tr>
<tr>
<td>Ability to Assess Relationships among Geospatial Technologies*</td>
<td>Ability to see the “Big Picture”*</td>
</tr>
<tr>
<td>Cartography</td>
<td>Business Understanding</td>
</tr>
<tr>
<td>Computer Programming Skills</td>
<td>Buy-in/Advocacy</td>
</tr>
<tr>
<td>Environmental Applications</td>
<td>Change Management*</td>
</tr>
<tr>
<td>GIS Theory and Applications*</td>
<td>Cost Benefit Analysis / ROI*</td>
</tr>
<tr>
<td>Geology Applications</td>
<td>Ethics Modeling</td>
</tr>
<tr>
<td>Geospatial Data Processing Tools</td>
<td>Industry Understanding</td>
</tr>
<tr>
<td>Photogrammetry</td>
<td>Legal Understanding</td>
</tr>
<tr>
<td>Remote Sensing Theory &amp; Applications</td>
<td>Organization Understanding</td>
</tr>
<tr>
<td>Spatial Information Processing</td>
<td>Performance Analysis &amp; Evaluation</td>
</tr>
<tr>
<td>Technical Writing*</td>
<td>Visioning</td>
</tr>
<tr>
<td>Technological Literacy*</td>
<td></td>
</tr>
<tr>
<td>Topology</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Analytical Competencies</strong></th>
<th><strong>Interpersonal Competencies</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Creative Thinking*</td>
<td>Coaching</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>Communication*</td>
</tr>
<tr>
<td>Model Building Skills</td>
<td>Conflict Management</td>
</tr>
<tr>
<td>Problem-Solving Skills*</td>
<td>Feedback Skills*</td>
</tr>
<tr>
<td>Research Skill</td>
<td>Group Process Understanding</td>
</tr>
<tr>
<td>Systems Thinking</td>
<td>Leadership Skills*</td>
</tr>
</tbody>
</table>

*Core competencies
<table>
<thead>
<tr>
<th>COMPETENCIES</th>
<th>ROLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applications</td>
</tr>
<tr>
<td>Ability to Assess Relationships Among Geospatial Technologies</td>
<td>●</td>
</tr>
<tr>
<td>Cartography</td>
<td></td>
</tr>
<tr>
<td>Computer Programming Skills</td>
<td>●</td>
</tr>
<tr>
<td>Environmental Applications</td>
<td>●</td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td>●</td>
</tr>
<tr>
<td>Geology Applications</td>
<td>●</td>
</tr>
<tr>
<td>Geospatial Data Processing Tools</td>
<td>●</td>
</tr>
<tr>
<td>Photogrammetry</td>
<td>●</td>
</tr>
<tr>
<td>Remote Sensing Theory and Applications</td>
<td>●</td>
</tr>
<tr>
<td>Spatial Information Processing</td>
<td>●</td>
</tr>
<tr>
<td>Technical Writing</td>
<td>●</td>
</tr>
<tr>
<td>Technological Literacy</td>
<td>●</td>
</tr>
<tr>
<td>Topology</td>
<td>●</td>
</tr>
<tr>
<td>Ability to see the “Big Picture”</td>
<td>●</td>
</tr>
<tr>
<td>Business Understanding</td>
<td>●</td>
</tr>
<tr>
<td>Buy-in/Advocacy</td>
<td>●</td>
</tr>
<tr>
<td>Change Management</td>
<td>●</td>
</tr>
<tr>
<td>Cost Benefit Analysis / ROI</td>
<td>●</td>
</tr>
<tr>
<td>Ethics Modeling</td>
<td>●</td>
</tr>
<tr>
<td>Industry Understanding</td>
<td>●</td>
</tr>
<tr>
<td>Legal Understanding</td>
<td>●</td>
</tr>
<tr>
<td>Organization Understanding</td>
<td>●</td>
</tr>
<tr>
<td>Performance Analysis &amp; Evaluation</td>
<td>●</td>
</tr>
<tr>
<td>Visioning</td>
<td>●</td>
</tr>
</tbody>
</table>
### Figure 1
Geospatial Technology Competency Model

<table>
<thead>
<tr>
<th>COMPETENCIES</th>
<th>ROLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applications Development</td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>●●●●</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>●●●●</td>
</tr>
<tr>
<td>Model Building Skills</td>
<td>●●●●</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Research Skill</td>
<td>●●●●</td>
</tr>
<tr>
<td>Systems Thinking</td>
<td>●●●●</td>
</tr>
<tr>
<td>Coaching</td>
<td>●●●●</td>
</tr>
<tr>
<td>Communication</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Conflict Management</td>
<td>●●●●</td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Group Process Understanding</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Leadership Skills</td>
<td>●●●●</td>
</tr>
<tr>
<td>Questioning</td>
<td>●●●●</td>
</tr>
<tr>
<td>Relationship Building Skills</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Self-Knowledge / Self-Management</td>
<td>●●●●●</td>
</tr>
</tbody>
</table>

© 2001 The University of Southern Mississippi
The University of Southern Mississippi reserves its ownership and proprietary rights of the Geospatial Technology Competency Model®. This material may be reproduced, redistributed, and used for educational purposes, but not for commercial or monetary gain.
The Geospatial Technology Competency Model© developed through The University of Southern Mississippi’s GeoSpatial Workforce Development Center most importantly provides a way to articulate the kinds of workers needed in the geospatial industry. The GTCM© provides a research-based set of competencies for hiring organizations to use to improve employee recruitment and selection and to create competency-based performance management systems to help professionally develop existing employees in the industry. The GTCM© offers a research framework for industry training providers and academic institutions to identify levels of expertise for required competencies to use for creating the most effective and efficient training and education opportunities.

The Geospatial Technology Competency Model© provides a model to help promote and influence national geospatial technology education and training in response to geospatial labor demands. Existing resources will be used to create systemic change in the academic infrastructure that will be able to support the development of a geospatial technology workforce. The geospatial competency model provides a systematic solution for public and private organizations to help develop a well-trained workforce as awareness intensifies about the potential of geospatial technologies in the marketplace.
The Geospatial Education Opportunities Workforce Development Center (GeoWDC) will use this study as the catalyst to provide leadership to public and private organizations in geospatial workforce learning and performance. The center will disseminate existing and recommended geospatial technology curricula information, models for geospatial technology practices, and maps of national standards to competencies for industry and educators in order to develop a geospatial technology workforce.

Alliances with major state universities and community colleges from around the country will be formed. There are numerous educational entities that have well-funded and nationally-respected research programs and facilities in geospatial technology areas. These academic partners will provide the institutional vehicles through which the actual training can take place, either through online course material or through face-to-face instruction. Participating academic institutions in this alliance will be selected based upon their given expertise in defined areas for which they can provide training. For instance, a selected university could provide training in precision agriculture, another in forestry, another institution in urban planning, etc.

By leveraging the expertise of universities, these partners provide both an arena for the training, as well as a source of potential trainees. They also enable the distribution of their skills throughout a nationwide network of affiliated geospatial institutions.

The Geospatial Technology Competency Model© offers an incredible capacity to develop and nurture an expanding pool of skilled workers who will be in increasing demand as the need for geospatial information increases; not only in the federal community but in the state, local, and private sectors as well. The Model helps move toward the goal of developing a well-trained workforce for the geospatial technology marketplace.

**CONCLUSION**

The participation from industry, governmental and educational community representatives was key to this research initiative. These partnerships are consistent with NASA’s commitment to create a customer/industry driven model and to utilize existing resources to create systemic change in the way students and the incumbent workforce are trained and retrained. The value of the Geospatial Technology Competency Model© will ultimately be measured by its implementation as a tool for performance management, employee recruitment and selection, career development, and as a curriculum framework for training and education.
Workforce Development Models for Geospatial Technology

References


Ingalls, J. (1979). Throw away your job descriptions and write competency models. Training, 16(4), 32-34.


Workforce Development Models for Geospatial Technology

Appendices

Role Profiles

Application Development .................................................................30
Coordination .........................................................................................33
Data Acquisition ....................................................................................36
Data Analysis ..........................................................................................39
Data Management ...................................................................................41
Management ............................................................................................45
Marketing ..................................................................................................50
Project Management ................................................................................54
Systems Analysis ....................................................................................57
Systems Management ..............................................................................61
Training .....................................................................................................63
Visualization ..............................................................................................67
A profile for each of the twelve roles begins on page 30 which includes the role definition, outputs and quality requirements, competencies and required levels of expertise, and ethical challenges as presented earlier in this report.

Role experts were asked to determine the level of expertise required for each competency as they performed in their specific geospatial technology role. The following scale was used:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – novice</td>
<td>cannot perform this competency satisfactorily in the work environment</td>
</tr>
<tr>
<td>1 – little better than novice</td>
<td>can perform this competency satisfactorily, but not without constant supervision and some assistance</td>
</tr>
<tr>
<td>2 – much better than novice</td>
<td>can perform this competency satisfactorily, but requires periodic supervision and some assistance</td>
</tr>
<tr>
<td>3 – intermediate</td>
<td>can perform this competency without supervision and assistance</td>
</tr>
<tr>
<td>4 – near expert</td>
<td>can perform this competency without supervision and assistance with more than acceptable speed and quality of work</td>
</tr>
<tr>
<td>5 – expert</td>
<td>can perform this competency with more than acceptable speed and quality, and with initiative and adaptability to special problems</td>
</tr>
</tbody>
</table>
Application Development

The role of identifying and developing tools and instruments to satisfy customer needs.

Outputs and Quality Requirements

1. Application document
   - it has user manuals
   - it has interface documents
   - it describes input and output specification and formats
   - it describes functioning of the application or program
   - it has adequate illustrations/graphics
   - it provides instructions for use of the software
   - it is in a format that is easily understandable by users of all levels

2. A fully functional application that meets customer specification or expectations
   - the outputs match the requirements
   - user input is considered when developing installation programs
   - the interface is user friendly

3. Software license mechanism
   - the licenses of the commercial off the shelf (COTS) are respected
   - the licenses of the developed Intellectual Property Rights (IPR) are respected
   - it identifies potential intellectual property for protection to management
   - it documents license manager installation and use

4. Documented solutions to defined problems
   - it has science-based interpretations, including interpretive products (e.g., maps)
   - it provides documentation/scientific testing results for the application
   - it has an explanatory text (report)
   - it provides description of process/steps to provide end solution

5. Application compliance
   - it ensures compliance with the laws of physics and technology
   - it meets specifications
6. **Identify appropriate available instruments and/or create specifications for new instruments**
   - the data provided by instrument matches application requirements
   - it identifies specific requirements for instruments that do not currently exist
   - it assesses the function of tools included in the applications
   - the proper tools being used

7. **Contingency plan**
   - it has developed potential alternatives to better react to changing situations or instrument failure

8. **Application testing**
   - it has verification and validation
   - it has been beta tested
   - it has testing plans, protocols and results publishing
   - it has been tested with live data
   - it has careful and thorough documentation of test results, protocols and procedures

9. **Ancillary support**
   - there are application performance monitoring products
   - it has a process established for remediation

<table>
<thead>
<tr>
<th>Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to see “Big Picture”</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Change Management</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Communication</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Computer Programming Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Environmental Applications</td>
<td>Much better than Novice</td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Industry Understanding</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Model Building Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Photogrammetry</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Remote Sensing Theory and Applications</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Research Skill</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Spatial Information Processing</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Systems Thinking</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Technical Writing</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Technological Literacy</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>
Ethical Challenges

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
4. Using client information for personal gain.
5. Falsifying data.
6. Assigning credit appropriately.
7. Making false claims about another’s behaviors or accomplishments.
8. Withholding information or establishing unrealistic expectations.
9. Be objective when examining and verifying the analysis of data.
10. Put in a full day’s work for a full day’s pay.
11. Protecting the integrity of all data.
Coordination

The role of inter-organizational facilitation and communication.

Outputs and Quality Requirements

1. Partnership development
   • it is inclusive
   • it has a diverse audience of partners
   • it involves multiple levels of organizations
   • it finds and engages other organizations to form partnerships
   • it finds organizational commonalities

2. Multi-organizational committee development
   • it respects organizational differences in consensus building
   • it invites all stakeholders to participate
   • it broadcasts committee activities to a broader audience who may have only peripheral interest

3. Meeting facilitation
   • it establishes meeting ground rules
   • it keeps meetings on time and on topic
   • it develops a meeting agenda
   • it develops or collects meeting information materials prior to meeting
   • it provides all meeting attendees with attendee list and meeting minutes
   • it explains meeting parameters up front
   • it pays attention to differences in nomenclature in order to facilitate efficient and effective communication

4. Policy review
   • it is thorough
   • it encourages reconciliation of potentially conflicting policies
   • it provides pertinent comments and recommendations in a timely manner
   • it facilitates periodic review of policies within organization and at the enterprise level

5. Conduct liaison activities
   • education of policy makers occurs
   • it has a thorough range of contacts

6. Report to management on outside issues affecting parent organization
   • it is accurate
   • it confines efforts to relevant issues
   • it has submissions of timely, complete and accurate reportage
   • it is timely with concise reports of activities and proposals
7. **Coordinate strategic planning for enterprise and organizations**
   - it identifies and eliminates redundancies in organizational plans
   - it advocates enterprise visioning
   - it encourages efficiencies in organizational plans

8. **Advocate alliances with professional organizations**
   - it participates at local/regional and/or national level of relevant professional organizations

9. **Communication and information exchange**
   - it is clear, comprehensive, and concise
   - it has effective methods of presenting information (such as briefings, e-mails, teleconferences, and presentations)
   - it selects the appropriate method of communication or presentation for a given situation
   - it is proficient in using presentation technology

<table>
<thead>
<tr>
<th>Competencies and Levels of Expertise</th>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to Assess Relationships among Geospatial Technologies</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Ability to see “Big Picture”</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Business Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Buy-in/Advocacy</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Change Management</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Coaching</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Conflict Management</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Cost-Benefit Analysis/ROI</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Group Processing Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Industry Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Leadership Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Legal Understanding</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Organization Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Questioning Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Relationship Building Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Self-Knowledge/Self-Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Technical Writing</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Visioning</td>
<td>Near Expert</td>
<td></td>
</tr>
</tbody>
</table>
Ethical challenges

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Avoiding conflicts of interest.
5. Recommending solutions appropriate for the customers’ or users’ needs.
6. Exercising power or authority judiciously.
7. Making misleading claims regarding return-on-investment.
8. Falsifying data.
9. Assigning credit appropriately.
10. Making false claims about another’s behaviors or accomplishments.
11. Be objective when examining and verifying the analysis of data.
12. Put in a full day’s work for a full day’s pay.
13. Protecting the integrity of all data.
**Data Acquisition**

The role of collecting geospatial and related data.

*Outputs and Quality Requirements*

1. **Data acquisition dictionary**
   - it defines variables in a dataset
   - it defines variable types
   - it defines original source and modifications
   - it is accurate

2. **Metadata**
   - it ensures correct attribution
   - it is created in a format that is compliant with company/customer policy
   - it is comprehensive
   - it is accurate
   - it is in a correct/consistent format
   - it is compliant with standards

3. **Document data acquisition process**
   - it has a progress report
   - it has clear delineation of steps involved in acquisition
   - it documents adversities and impediments in data acquisition process
   - it is comprehensive
   - it is concise
   - it is fully documented to allow understanding of the data acquisition process

4. **Acquisition/access requests**
   - it is accurate
   - it is timely
   - there is knowledge of correct format, and other submission requirements

5. **Data acquisition contract development**
   - it is comprehensive
   - it is accurate
   - data requirements are clearly spelled out in draft contract

6. **Data (geospatial and non-geospatial)**
   - all data types are compliant with company policy
   - it facilitates access to external or shared geospatial databases
   - it is spectrally accurate
   - it is spatially accurate
   - it has accurate attributes
   - it is in proper format for the user (raster, vector, point)
   - it is received in a timely manner
   - it is scrubbed as appropriate
7. **Verify acquired data meets product specification or data content standards**
   - it has data quality review
   - it develops data sets compatible with the problem being solved
   - it meets the requirements of the proposal

8. **Define data sets and requirements**
   - it has identification of data requirements
   - definitions include data format type(s)
   - it meets the needs of company/customer
   - it has accuracy to a standard

9. **Security Compliance**
   - access levels are appropriate and are met
   - access levels are clearly defined and indicated
   - it addresses both organizational and customer requirements

10. **Sensor tasking schedules**
    - it is timely
    - it is accurate
    - it is comprehensive
    - there is knowledge of the availability and tasking requirements to access various data sensors

11. **Define all appropriate data sources**
    - there is understanding and knowledge concerning various sources of data
    - alternative sources for the same data have been identified
    - it screens data sources for applicability to application requirements
    - it is comprehensive
    - it is consistent with data requirements

12. **Web page**
    - it is understandable
    - it displays quickly
    - color and symbols are used appropriately
    - downloading bandwidth is considered in design

13. **Data format transformation**
    - it has data quality review
    - the digital product is an accurate representation of the non-digital product
    - it is an accurate transformation
<table>
<thead>
<tr>
<th>Competencies and Levels of Expertise</th>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cartography</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Computer Programming Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Geospatial Data Processing Tools</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Performance Analysis &amp; Evaluation</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Photogrammetry</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Remote Sensing Theory and Applications</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Spatial Information Processing</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Technological Literacy</td>
<td>Intermediate</td>
<td></td>
</tr>
</tbody>
</table>

**Ethical Challenges**

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Recommending solutions appropriate for the customers’ or users’ needs.
5. Pricing or costing products or services fairly.
6. Falsifying data.
7. Assigning credit appropriately.
8. Withholding information or establishing unrealistic expectations.
9. Be objective when examining and verifying the analysis of data.
10. Put in a full day’s work for a full day’s pay.
11. Protecting the integrity of all data.
Data Analysis and Interpretation

The role of processing data and extracting information to create products, drive conclusions, and inform decision-making reports.

Outputs and Quality Requirements

1. **Interpretive products (e.g. maps)**
   - appropriate datasets for analytical review are selected
   - the data is complete
   - it is accurate
   - data is repeatable
   - data meets specifications
   - it is consistent
   - it meets customer requirements

2. **Temporal and spatial trends**
   - appropriate datasets for analytical review are selected
   - the data is complete
   - it is accurate
   - data is consistent and repeatable
   - appropriate comparisons are made

3. **Recommendations for database refinements and collection procedures**
   - appropriate datasets for analytical review are selected
   - complete datasets are selected
   - proper data collection techniques have been implemented
   - no data gaps in the imagery are present

4. **Recommendations for integrating hardware, software, and other computer related services for a specific application**
   - they meet customer requirements
   - they are accurate
   - they are consistent with specific scientific applications

5. **Mathematical transformations (using computer programs to develop algorithms, event tables, histograms, etc.)**
   - proper mathematical tools are selected
   - results are consistent with customer expectations
   - the output provides appropriate imagery detail
   - uses proper processing procedures

6. **Information products to decision makers for inclusion in the preparation of briefings, reports or other summary presentations.**
   - they are scientifically reasonable
   - they are understandable
   - they are accurate
<table>
<thead>
<tr>
<th>Competencies and Levels of Expertise</th>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cartography</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Change Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Environmental Applications</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Ethics Modeling</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Geology Applications</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Geospatial Data Processing Tools</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Photogrammetry</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Remote Sensing Theory and Applications</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Research Skill</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Spatial Information Processing</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Technical Writing</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Technological Literacy</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Topology</td>
<td>Near Expert</td>
<td></td>
</tr>
</tbody>
</table>

**Ethical Challenges**

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Recommending solutions appropriate for the customers’ or users’ needs.
5. Pricing or costing products or services fairly.
6. Making misleading claims regarding return-on-investment.
7. Using client information for personal gain.
8. Falsifying data.
9. Making false claims about another’s behaviors or accomplishments.
10. Withholding information or establishing unrealistic expectations.
11. Be objective when examining and verifying the analysis of data.
12. Put in a full day’s work for a full day’s pay.
13. Protecting the integrity of all data.
Data Management

The role of cataloging, retrieving and distributing geospatial data.

Outputs and Quality Requirements

1. **Ensure technical implementation meets policy**
   - it distributes the data
   - it monitors changes in policy that will impact operation of data management function

2. **Search, order, and retrieve data**
   - the correct data appears as requested
   - it provides an easy-to-use way of retrieving search query information
   - it identifies and retrieves data
   - it is user friendly
   - it is efficient
   - it is accurate

3. **Data configuration management**
   - there is a data dictionary
   - there is a data format
   - the data is configured to be easily found and satisfies user requirements

4. **Clearinghouse**
   - it is user friendly
   - it uses an understandable interface
   - it has regular updates
   - it maintains operational requirements with National Spatial Data Initiative Clearinghouse policy
   - it is arranged to easily direct users to the right sources of data

5. **Versioning**
   - it is well-documented
   - it uses controlled multi-user updating of data
   - data is consistently well marked and documented as to the version
   - data reflects the most current situation
   - it is timely

6. **Data backup**
   - it is timely
   - it completely protects all data
   - it is consistent
   - it has a regular schedule
   - backup coincides with a data disaster recovery plan
   - it is comprehensive
   - it verifies backup procedures work as planned integrated with data disaster recovery plan
7. **Security implementation and support**
   - access is controlled
   - there are user accounts
   - data is protected
   - it protects classified information

8. **Data warehouse**
   - it properly stores/organizes data
   - it makes for easy retrieval
   - it is a safe and secure data storage area

9. **Data archives**
   - there is archival processing
   - it is secure
   - it is "living" -i.e., data are readily accessible
   - it properly archives previous data
   - it is comprehensive

10. **Data subsets**
    - custom data pulls are available
    - it includes proper data and documentation
    - data subsets require combining internal and external data and distribution requirements are not validated

11. **Data disaster discovery plan**
    - it allows for quick recovery
    - procedures allow recovery of data
    - it schedules "fire drills"
    - it identifies all data that should be protected
    - it provides schedule for backups

12. **Data structure plan**
    - data is organized to meet user requirements logical and physical models are understandable and internally consistent
    - logical and physical models are understandable and internally consistent
    - data structure and storage methodology are consistent with each other

13. **Data updating**
    - it ensures that data is updated in accordance with user requirements
    - it has chronology maintained to support versioning
    - there is verification of data updates before committing them to the database
14. **Roles and responsibilities document**
- it drafts and implements a roles and responsibility document
- it ensures direct reports know and understand their roles and responsibilities
- it periodically reviews document for currency and supports accountability

15. **Storage management**
- it creates a safe and secure data storage environment
- the data is stored efficiently
- it supports timing throughput requirements

16. **Catalogs**
- it has data catalogs
- it has metadata catalogs
- there is metadata management
- it is comprehensive
- it is accurate
- it provides accurate descriptions of data, data type and data holdings

17. **Distribution system**
- it is user friendly
- it is efficient
- it is effective
- it has a clearly defined process for obtaining data, both internal and external to the organization
- appropriate delivery is made to the appropriate end-user

<table>
<thead>
<tr>
<th>Competencies and Levels of Expertise</th>
<th>Role-Specific Competencies</th>
<th>Level of Expertise</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to see “Big Picture”</td>
<td></td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Change Management</td>
<td></td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Computer Programming Skills</td>
<td></td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Cost-Benefit Analysis/ROI</td>
<td></td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Creative Thinking</td>
<td></td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Feedback Skills</td>
<td></td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td></td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Leadership Skills</td>
<td></td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Model-Building Skills</td>
<td></td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td></td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Technological Literacy</td>
<td></td>
<td>Near Expert</td>
<td></td>
</tr>
</tbody>
</table>
Ethical Challenges

1. Protecting all intellectual property.
2. Ensuring truth in claims, data, and recommendations.
3. Recommending solutions appropriate for the customers’ or users’ needs.
4. Pricing or costing products or services fairly.
5. Using client information for personal gain.
6. Falsifying data.
7. Withholding information or establishing unrealistic expectations.
8. Put in a full day’s work for a full day’s pay.
9. Protecting the integrity of all data.
Management

The role of efficiently and effectively applying the company's mission using financial, technical and intellectual skills and resources to optimize the end-products.

Outputs and Quality Requirements

1. Performance Management
   • work is reviewed for consistency with organization policy and goals
   • work is consistent with organization and policy goals
   • there are meeting cost, schedule and technical performance requirements
   • feedback to employee, both positive and negative, is given on a continual basis, not just at appraisal time

2. Linkage to other groups/organizations
   • it has periodic meetings with constituent groups
   • it stays abreast of developments related to industry and standards.
   • they coordinate work and resources with other units whose work affects or is affected by the unit’s work

3. Work environment
   • it has work directions and plans
   • it has a project specific work breakdown structure developed with assigned responsibilities, resources, and expected task completions dates
   • management has clear visibility into work process status

4. Standards
   • there are clearly delineated standards
   • professional standards are met or exceeded
   • employees have a clear understanding of professional standards
   • it uses peer review and recognition to further excellence in applying standards
   • verification and validation activities are a required part of the development process

5. Conflict Resolution
   • internal and external conflicts are resolved in accordance with established procedures and settled in a fair and equitable manner
   • it separates the person from the problem, concentrates on shared interests, creates options, and is creative in offering political solutions
   • it defines a clear policy, criteria and procedure
6. Recognition of organization/work unit responsibilities
   • it reviews workflow structure to ensure immediate work products
     support organization mission of the organization/work unit
   • it reviews workflow summaries from other units within the
     organization to improve efficiency and eliminate redundancy
   • it recognizes data and knowledge sharing is not a unary process

7. Management Control
   • it has an effective interface with upper management
   • organization policies and practices are disseminated to all
     employees and understood by all employees
   • employees have a clear concept of upper management’s vision
   • it provides management with sufficient unbiased facts for
     making decisions
   • it promotes the use of ethical practices and procedures when
     managing the work unit

8. Comprehensive Planning
   • it has short-range planning
   • it has long-range plans and policy
   • it develops concise relevant plans to clearly lead staff and
     subordinates, while maintaining relevance and comprehension
     for the organization
   • it has consistency of the operational, tactical and strategic plans
   • it has well-articulated metrics and benchmarks to measure
     progress

   • strategic plans have clear goals and objectives that carry out the
     mission according to the vision
   • organizational policies are aligned and consistent with
     governmental requirements
   • policies are consistent with industry-defined ethical codes
10. **Staffing recruitment, selection, and assignment of employees**

- employees are given appropriate notice and time to improve non-acceptable performance prior to formal performance evaluation
- employee termination is carried out in a professional manner
- equal opportunity is given to applicants
- employee satisfaction is high, based on survey instruments
- all hiring and termination actions conform to all existing legal requirements
- a promotion process is clearly defined
- employee recruitment activities result in an adequate pool of qualified candidates
- employee turnover is within acceptable levels as defined by corporate policy
- hiring decisions are made in a timely fashion
- employees are made aware of company policies
- well-defined salary and benefit plans are in place for all employees
- training needs are determined for individuals and groups through collaboration with training professionals

11. **Resource Acquisition and allocation**

- it has resources
- it prioritizes acquisitions
- resources are obtained with sufficient lead-time to accomplish objectives in accordance with budget planning
- needs requirements are consistent with planning resources

12. **Budgets and Financial Management**

- budgets are drafted and submitted for the work unit or organization
- budgets reflect the actual costs of activities by the department involved
- fiscal controls are in place to allow close monitoring of financial resources
- it fosters an environment where cost/benefit outcomes are continuously improved
- long-term financial requirements needed to achieve work-unit or organization objectives are met
- monitors profits and expenses to ensure work-unit profitability
- justification for the work-unit budget is made
- organization policies regarding budget preparation, submission, defense, and long-term administration are met
<table>
<thead>
<tr>
<th>Competencies and Levels of Expertise</th>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to Assess Relationships among Geospatial Technologies</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Ability to see “Big Picture”</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Business Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Buy-in/Advocacy</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Change Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Coaching</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Conflict Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Cost-Benefit Analysis/ROI</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Ethics Modeling</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Group Process Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Industry Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Leadership Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Model-Building Skills</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Organization Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Performance Analysis &amp; Evaluation</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Questioning Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Relationship Building Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Self-Knowledge/Self-Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Systems Thinking</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Technical Writing</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Technological Literacy</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Visioning</td>
<td>Near Expert</td>
<td></td>
</tr>
</tbody>
</table>
Ethical Challenges

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Avoiding conflicts of interest.
5. Managing personal biases.
6. Recommending solutions appropriate for the customers’ or users’ needs.
7. Pricing or costing products or services fairly.
8. Exercising power or authority judiciously.
9. Making misleading claims regarding return-on-investment.
10. Using client information for personal gain.
11. Falsifying data.
12. Assigning credit appropriately.
13. Making false claims about another’s behaviors or accomplishments.
14. Withholding information or establishing unrealistic expectations.
15. Be objective when examining and verifying the analysis of data.
16. Protecting the integrity of all data.
Marketing

The role of identifying customer requirements and needs and effectively communicating those needs and requirements to the organization, as well as promoting geospatial solutions.

Outputs and Quality Requirements

1. Plans to market geospatial products congruent with corporate strategic plan
   - they are integrated with business and strategic plans
   - they include measurable milestones of targeted goals (both qualitative and quantitative)
   - they reflect knowledge of the user population’s needs and the benefits to its members
   - they incorporate the best thinking of all business units involved in delivering geospatial services and products
   - they include a market budget
   - there is an ability to communicate a vision of where the technology is going and the benefits to the customer

2. Promotional and informational material for geospatial products and services
   - it supports the objectives of the marketing plan
   - it gives relevant information (i.e. objectives, benefits, features, costs, delivery options)
   - it is directed to the defined population
   - it produces qualified leads
   - it is easy to understand
   - it creates brand identification
   - it promotes the product(s) offered for sale
   - it contains customer testimonials and examples of users of where the product is in use
   - it provides company contact information, website, etc.
   - it contains sufficient technical detail to enable the potential customer to understand how the product or service is differentiated from other organizational offerings

3. Geospatial marketing and sales presentations
   - they identify outcomes, benefits, and applications
   - they are tailored for the specified audience
   - they stay on target, stick to the point, present intended information, and generate discussion
   - they enhance the buyer-seller relationship
   - they are clear, articulate, and well-organized
   - they accurately represent the product/service
4. **Contracts or agreements to provide geospatial service**
   - the negotiation process is win-win
   - there is a real commitment for all parties to participate
   - there is clarity and internal agreement on desired results
   - long-term relationships are developed
   - promises are kept
   - logistics and schedules are clear
   - they are consistent with organization’s mission
   - agreements for customers are put together in a timely manner
   - all intellectual product rights are clearly articulated
   - all costs are identified

5. **Geospatial sales/business leads**
   - follow-up is timely and planned according to long-range client development
   - there is a mix of new and repeat business
   - sufficient quantity and quality of leads are generated
   - leads are sufficiently qualified as to potential
   - referrals from satisfied customers are used
   - development of tracking system is in place and kept current

6. **Articulation of customer needs to upper management**
   - it keeps senior management informed of changing customer needs or situations
   - it indicates strengths and weaknesses of market offerings indicated by customers
   - it provides recommendations to management to maximize near term and long term profits

7. **Articulation of customer needs to internal technical staff**
   - requests from customer base for upgrades to current products or development of new products are transmitted
   - problems data and/or product problems to technical staff are transmitted
   - technical staff to work with innovative customer requests are encouraged
   - ideas for new products are provided
8. **Market research**
   - it identifies potential market opportunities
   - it identifies opportunities to partner with other entities on products and services
   - it identifies products that currently satisfy the needs of the customer
   - it identifies sectors where potential penetration appears to be high
   - competitor analysis and information gathering is conducted
   - it identifies similar products or services offered by competitors
   - periodic cost/price analysis is conducted to ensure that cost and price data is in line with production costs and competition

9. **Participation at conference, symposia, and expositions**
   - it maintains contacts with industry changes and industry leadership
   - it represents company in professional manner
   - it maintains and updates knowledge about product/services
   - it schedules activities to meet potential customers
   - it establishes a relationship with customers outside of sales
   - it arranges to have a high level of presence at the event by presenting or sponsoring a booth

### Competencies and Levels of Expertise

<table>
<thead>
<tr>
<th>Competencies and Levels of Expertise</th>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to Assess Relationships among Geospatial Technologies</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Ability to see “Big Picture”</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Buy-in/Advocacy</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Change Management</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Cost-Benefit Analysis/ROI</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Ethics Modeling</td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Industry Understanding</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Leadership Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Questioning Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Relationship Building Skills</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Self-Knowledge/Self-Management</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Technical Writing</td>
<td>Near Expert</td>
<td></td>
</tr>
<tr>
<td>Visioning</td>
<td>Near Expert</td>
<td></td>
</tr>
</tbody>
</table>
Ethical challenges

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Avoiding conflicts of interest.
5. Managing personal biases.
6. Recommending solutions appropriate for the customers’ or users’ needs.
7. Pricing or costing products or services fairly.
8. Making misleading claims regarding return-on-investment.
10. Falsifying data.
11. Assigning credit appropriately.
12. Making false claims about another’s behaviors or accomplishments.
13. Withholding information or establishing unrealistic expectations.
14. Be objective when examining and verifying the analysis of data.
15. Put in a full day’s work for a full day’s pay.
16. Protecting the integrity of all data.
Project Management

The role of effectively overseeing activity requirements to produce the desired outcomes on time and within budget.

Outputs and Quality Requirements

1. Requirements/scope definition and management
   • deliverables are well defined and understood by stakeholders
   • changes to project scope are understood and agreed to by stakeholders
   • deliverables meet requirements of stakeholders
   • requirements can realistically be accomplished
   • specifications are realistic and necessary

2. Risk management
   • risks are documented and understood
   • risk mitigations are documented
   • risk documentation is maintained through the life of the project
   • risks are reviewed at different stages

3. Project resources management
   • the use of resources is closely monitored to ensure that they are adequate to insure project completion
   • overruns and causes are communicated as they occur
   • contingent resource plans are developed for resources along the critical path

4. Work Breakdown Structure
   • project is broken into quantifiable, understandable, units of effort
   • WBS line items have well-defined units of activity or deliverable

5. Project schedule maintenance
   • realistic schedules are drafted and constantly updated
   • it meets deadlines and milestones
   • it makes team aware of schedule and milestones
   • changes to schedule represent realistic, achievable modifications
   • there is a clear link to dependent tasks

6. Project performance monitoring
   • project activities, goals, and milestones are periodically reviewed and reported
   • scheduled and unscheduled briefings to team management, customers, and other stakeholders are made
   • project documentation and evaluation are retained for a specified time after completion of project
   • project performance is understandable as measurable unit
7. **Project status briefings**
   - scheduled and unscheduled briefings to the team, management, customers, and other stakeholders are made
   - it addresses performance since previous briefing
   - it identifies issues relating to potential deviations from milestones/schedule
   - it identifies action items involving internal staff and customer/external staff for project requirements

8. **Project team meetings**
   - conducted only when necessary and in such a manner as to minimize use of valuable team resources
   - it includes well-defined meeting objectives
   - it evaluates progress on current action items
   - new action items are set that relate to unscheduled tasks
   - risk mitigations are documented

9. **Management of customer expectations**
   - the expectations of the program outcomes are well understood by all constituencies
   - it updates customer on a regular basis
   - protocols for customer (end users) project manager interaction are established to respond to developing situations
   - the customer understand project performance at defined intervals
   - it understands customer expectations

10. **Project protocols**
    - proposals address all aspects for the RFP
    - proposals are developed with reasonable expectations for procuring sufficient resources to complete work
    - it includes well-defined deliverables
    - it includes well-defined milestones
## Competencies and Levels of Expertise

<table>
<thead>
<tr>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Understanding</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Change Management</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Communication</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Conflict Management</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Cost-Benefit Analysis/ROI</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Ethics Modeling</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Group Process Understanding</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Leadership Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Performance Analysis &amp; Evaluation</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Relationship Building Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Technical Writing</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Technological Literacy</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Visioning</td>
<td>Near Expert</td>
</tr>
</tbody>
</table>

### Ethical challenges

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Avoiding conflicts of interest.
5. Recommending solutions appropriate for the customers’ or users’ needs.
6. Pricing or costing products or services fairly.
7. Falsifying data.
8. Assigning credit appropriately.
9. Withholding information or establishing unrealistic expectations.
10. Be objective when examining and verifying the analysis of data.
11. Put in a full day’s work for a full day’s pay.
12. Protecting the integrity of all data.
**Systems Analysis**

The role of assessing requirements for system capacities including inputs, outputs, processes, timing and performance, as well as recommending necessary additions or adaptations.

**Outputs and Quality Requirements**

1. **Products specifications**
   - it is technically correct
   - it is realizable
   - specifications are unambiguous
   - it is accurate
   - it is meaningful
   - it is understandable

2. **Technology assessment/investigations**
   - the technology matches the project requirements
   - it is thorough
   - it is accurate
   - it is needed
   - it identifies the most economical technology to meet project specs
   - it avoids vendor bias
   - it does not reinvent the wheel
   - it incorporates input from the customer

3. **Functional requirements document**
   - the specifications support the mission
   - there are good system functional requirements used as a baseline for the program
   - the functional requirements are supported by technical requirements
   - it is complete
   - it is well-organized
   - it is concise

4. **Interface specification**
   - it meets needs of users at all levels
   - it is efficient
   - it is workable
   - it matches IT operational architecture

5. **Cost/benefit analysis**
   - the analysis shows how the current process will be improved
   - it is accurate
   - it is comprehensive
6. **Sensor specifications**  
   - it meets needs of required data  
   - it is determined what additional capability can be added on at an additional cost  
   - it is science-based  
   - it is technically achievable  
   - it is not cost prohibitive  

7. **Determination of compliance with contractual requirements**  
   - the specs are compliant with the contractual requirements  
   - it is thorough  
   - it is comprehensive  
   - it is accurate  

8. **Case studies**  
   - it is relevant  
   - it is of general or of wide interest  
   - it is understandable  
   - it is thorough  

9. **Requirements trace ability matrix**  
   - requirements are articulated by use of the matrix  

10. **Conceptual design of database(s)**  
    - the data sets to be collected are matched with the database architecture  
    - ensures flexibility for changes in data types/amounts  
    - it is expandable  
    - it is scalable  
    - logical data structures and data relationships are established  
    - data dictionary is a clearly defined data type  

11. **Inter-operability assessment**  
    - all elements of the system have been identified and protocols for linking the various components have been identified as whether existing or needing to be developed  
    - it is thorough  

12. **Testing and exit criteria**  
    - a comprehensive testing plan is schedule in basic design activities  
    - various “what if” scenarios are developed if individual system components fail the testing process  
    - it is thorough/comprehensive  
    - it is relevant
13. **Data dictionary**
   - critical data elements are defined
   - acronyms are spelled out
   - different types of data formats are identified
   - it is comprehensive
   - it is accurate
   - it defines data types and structures

14. **Conceptual design of application necessary to create products specified in requirements**
   - review of the design is conducted to ensure product specific requirements are met
   - it is relevant/of general or wide interest

15. **Assessment of applicable standards**
   - the standards are being met
   - the standards are applicable

16. **Configuration control**
   - the change process is well defined and controlled
   - the configuration control process includes all of the relevant areas

17. **Search and review of existing technical documentation**
   - it is comprehensible
   - it is thorough

18. **Develops and monitors implementation plan**
   - milestones are realistic with respect to schedules defined in the contract
   - the plan clearly identifies the interrelationships between elements
   - the plan is fluid and updated on an effective frequency
   - milestones are measurable
   - it is comprehensive

19. **Contribution to project review (i.e. PDR, CDR, etc.)**
   - there is a feedback methodology in place to "add rudder control" to the project
   - it is fair
   - it is thorough
   - the analyses support the project direction
<table>
<thead>
<tr>
<th>Competencies and Levels of Expertise</th>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to Assess Relationships</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Ability to see “Big Picture”</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Buy-in/Advocacy</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Change Management</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Computer Programming Skills</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Creative Thinking</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Feedback Skills</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Geospatial Data Processing Tools</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Performance Analysis &amp; Evaluation</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Questioning Skills</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Relationship Building Skills</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Self-Knowledge/Self-Management</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Systems Thinking</td>
<td></td>
<td>Expert</td>
</tr>
<tr>
<td>Technical Writing</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Technological Literacy</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Visioning</td>
<td></td>
<td>Near Expert</td>
</tr>
</tbody>
</table>

**Ethical challenges**

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Avoiding conflicts of interest.
5. Managing personal biases.
6. Recommending solutions appropriate for the customers’ or users’ needs.
7. Making misleading claims regarding return-on-investment.
8. Falsifying data.
9. Assigning credit appropriately.
10. Making false claims about another’s behaviors or accomplishments.
11. Withholding information or establishing unrealistic expectations.
12. Be objective when examining and verifying the analysis of data.
13. Put in a full day’s work for a full day’s pay.
14. Protecting the integrity of all data.
### Systems Management

**Outputs and Quality Requirements**

The role of integrating resources and developing additional resources to support spatial and temporal user requirements.

1. **Systems budget**
   - it ensures proposed systems upgrades are in line with budget realities
   - expenditure vs. milestone planning and tracking is in place

2. **Hardware upgrades**
   - it stays current on hardware functionalities
   - it makes hardware recommendations to purchasing authorities
   - budget constraints are observed

3. **Systems support**
   - demands on system functionality are understood
   - help desk is user friendly
   - help desk responds to requests in a timely manner

4. **Software management**
   - it enhances system functionality
   - it ensures compliance with software license agreements
   - new releases are evaluated
   - software upgrades are planned

5. **Systems performance monitoring**
   - it is comprehensive
   - it is efficient
   - it ensures corrective action is taken

6. **System integration plan development**
   - it is compliant with needs of company
   - it is in accordance with financial constraints

7. **Specifications development for hardware and software**
   - it is complete

8. **Systems compliance to specifications**
   - systems integration is verified
   - security concerns are adequately addressed

9. **System backups**
   - it is timely
   - it is complete
   - processes for backups are established

10. **System maintenance**
    - it is timely
    - it is thorough
    - it is efficient
<table>
<thead>
<tr>
<th>Competencies and Levels of Expertise</th>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to Assess Relationships</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>among Geospatial Technologies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to see “Big Picture”</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Change Management</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Conflict Management</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Cost-Benefit Analysis/ROI</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Creative Thinking</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Ethics Modeling</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Feedback Skills</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Geospatial Data Processing Tools</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Group Process Understanding</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Leadership Skills</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Model-Building Skills</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Organization Understanding</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Performance Analysis &amp; Evaluation</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Questioning Skills</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Relationship Building Skills</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>Remote Sensing Theory</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td>and Applications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Knowledge/Self-Management</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Systems Thinking</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Technical Writing</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Technological Literacy</td>
<td></td>
<td>Near Expert</td>
</tr>
<tr>
<td>Visioning</td>
<td></td>
<td>Intermediate</td>
</tr>
<tr>
<td><strong>Ethical challenges</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Maintaining appropriate confidentiality.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Protecting all intellectual property.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ensuring truth in claims, data, and recommendations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Recommending solutions appropriate for the customers’ or users’ needs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Exercising power or authority judiciously.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Using client information for personal gain.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Withholding information or establishing unrealistic expectations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Be objective when examining and verifying the analysis of data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Put in a full day’s work for a full day’s pay.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Protecting the integrity of all data.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Training

The role of analyzing, designing, and developing instructional and non-instructional interventions to provide transfer of knowledge and evaluation for performance improvement.

Outputs and Quality Requirements

1. **Learning environment**
   - individuals feel safe to try new skills and behaviors
   - the facilitator models behavior consistent with the goals of the program
   - self-esteem is maintained or enhanced
   - individual differences are respected
   - the environment supports the learning process (i.e. comfortable temperature, seating, noise level)
   - there is expertise in teaching and methodologies
   - there is expertise in subject matter

2. **Instructional material (such as job aids, instructor guides, workbooks)**
   - they clearly communicate the information or concept
   - they maintain learner interest
   - they are accurate and complete
   - they add visual impact to the written or spoken word
   - they are up-to-date
   - appropriate use of visual aids is maintained
   - examples are appropriate to the organization

3. **Facilitation of group discussions**
   - each group member feels valued and listened to; self-esteem is maintained or enhanced
   - participation is encouraged
   - agreed-upon levels of confidentiality are maintained
   - adequate time is provided for discussion, debriefing, and application
   - there is enough flexibility to respond to group needs and issues as they arise
   - participants are provided opportunities to explore ideas in a safe manner
   - group members feel the experience is meaningful

4. **Evaluation and feedback**
   - competencies being tested are relevant and clearly defined
   - feedback is timely and relevant
   - instructions are clear and easily understood
   - feedback is presented in a professional and constructive manner
   - the trainee feels no threat of retribution
   - evaluation criteria is well understood by the trainee
   - feedback sufficiently motivates employee to work hard to grasp the material in order to advance career progression
5. **Organizational training plan**
   - it reflects competencies that are required to meet organization’s mission
   - it is documented in strategic plan
   - training plan is realistic in light of on-going company activities
   - shows multiple training paths that are directly tied to career progression
   - company training goals are comparable with qualifications of the training organization
   - it provides estimated costs of implementation of plan

6. **Presentations of material**
   - connections between the instructional event and on-the-job issues/problems are made
   - the facilitator makes adaptations according to the unique issues of the group
   - presentations are directly linked to the intended learning objectives
   - the methodology used is appropriate to multiple learning styles
   - individuals’ issues, concerns, and expectations about the material’s content are addressed
   - examples related to the learning points are provided
   - they make appropriate use of support materials and aids (presentation software, flip charts, handouts)
   - the learning points are clear, accurate and organized
   - materials are up-to-date

7. **Facilitation of structured learning events (such as case studies, role plays, games, simulations, tests)**
   - connections are made between the event and on-the-job issues/problems
   - the facilitator makes adaptations according to the unique issues of the group
   - participants are able to identify what they are doing well or might do differently on the job
   - timely, sensitive, and relevant feedback is provided
   - participants are physically and psychologically safe when moving in and out of role plays and simulations
   - participants make generalizations and contribute application ideas
   - the facilitator and participants discuss and summarize key points
   - individuals understand the event’s purpose
   - individuals issues, concerns, and expectations about the event are addressed
   - manage length of sessions between breaks to maintain learner involvement and maximize ability to learn
8. **Facilitation of media-based learning events (such as videotapes, films, audio tapes, teleconferences, computer-assisted instruction)**
   - connections are made between the instructional event and on-the-job issues and problems
   - the intended objectives are clearly presented to participants
   - the objectives are consistent with the program design
   - equipment is operated properly and backup systems or contingency plans exist for use in the event of equipment failure
   - transitions between media segments and other portions of the program are smooth
   - the instructor makes adaptations of audiovisual use according to unique issues of the group
   - materials have direct relevance to the point under discussion and are not used just because they are available

9. **Feedback to learners**
   - feedback is clearly communicated
   - it is supported by specific examples
   - it is given as soon after the behavior as possible
   - feedback is given in a respectful manner
   - feedback provides suggestions of course of action

10. **Training programs**
    - curriculum is appropriate for current industry trends
    - the program is sufficiently rigorous to challenge all students
    - there is direct immersion of the student in the technology
    - scheduled so employee can immediately apply learning to work situation
    - courses match employee skill levels
    - time is set aside to take full advantage of the training opportunity
    - hands on time is appropriate to the learning objective

11. **Individuals with new knowledge, skill, attitudes**
    - individuals are able to apply new learning
    - the learning is relevant to job performance and/or career development
    - individuals are able to perform more effectively
### Competencies and Levels of Expertise

<table>
<thead>
<tr>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to Assess Relationships among Geospatial Technologies</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Ability to see “Big Picture”</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Buy-in/Advocacy</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Change Management</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Coaching</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Communication</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Conflict Management</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Cost-Benefit Analysis/ROI</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Ethics Modeling</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Geospatial Data Processing Tools</td>
<td>Intermediate</td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Group Process Understanding</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Industry Understanding</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Leadership Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Model-Building Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Performance Analysis &amp; Evaluation</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Questioning Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Relationship Building Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Research Skill</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Self-Knowledge/Self-Management</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Spatial Information Processing</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Systems Thinking</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Technical Writing</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Technological Literacy</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Visioning</td>
<td>Near Expert</td>
</tr>
</tbody>
</table>

### Ethical Challenges

1. Protecting all intellectual property.
2. Ensuring truth in claims, data, and recommendations.
3. Recommending solutions appropriate for the customers’ or users’ needs.
4. Using client information for personal gain.
5. Falsifying data.
6. Assigning credit appropriately.
7. Making false claims about another’s behaviors or accomplishments.
8. Withholding information or establishing unrealistic expectations.
9. Being objective when examining and verifying the analysis of data.
10. Putting in a full day’s work for a full day’s pay.
11. Protecting the integrity of all data.
Visualization

The role of rendering data and information into visual geospatial representations.

Outputs and Quality Requirements

1. Paper maps/charts
   - it is accurate
   - it is detailed
   - it meets accepted cartographic standards
   - it is appropriate for state use
   - it creates figure ground (ensuring that the most important attribute of the map is displayed as such)
   - it is user friendly
   - it is readable
   - it has appropriate scale and projection
   - it is conscious of scale/final print size

2. Digital maps/charts
   - it is accurate
   - it is detailed
   - it is user friendly
   - it meets appropriate cartographic standards
   - it creates figure ground (ensuring that the most important attribute of the map is displayed as such)
   - it considers resolution

3. Charts/graphs
   - the chart/graph can stand alone
   - it is accurate
   - selection of chart form is best suited to presentation of material
   - it is legible
   - a legend is included

4. Cartographic standards compliance
   - product is compliant with standards
   - deviations are recognized and corrected or noted if not correctable

5. Video production
   - it is an accurate portrayal of the subject matter
   - there is smooth frame transition

6. Hue saturation shaded relief
   - it is accurate
   - it is appropriate for the data
   - it uses appropriate colors to convey elevation

7. False color images (pseudo-color)
   - uses proper selection of grayscale levels and number of contrast of adjacent scales of colors
8. **Dynamic representations/animations**
   - representation is smooth between data slices
   - uses proper resolutions

9. **3D representations**
   - it uses proper relationships and aspect ratios
   - the representation appropriately depicts the data type

10. **Presentation development support**
    - visualization support presentation message
    - there is good use of symbology
    - it uses appropriate color pallet/patterns
    - it meets the needs of the customer
    - it is in compliance with internal standards

11. **Web page**
    - it is understandable
    - it displays quickly
    - color and symbol use are appropriate
    - downloading bandwidth is considered in design

12. **Fly through/fly over**
    - it is smooth
    - it is reasonably accurate
    - it has appropriate vertical exaggeration

13. **Virtual environment**
    - proper selection of targets of interest are used
    - resolution requirements are met
### Competencies and Levels of Expertise

<table>
<thead>
<tr>
<th>Role-Specific Competencies</th>
<th>Level of Expertise Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to Assess Relationships among Geospatial Technologies</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Buy-in/Advocacy</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Cartography</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Change Management</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Communication</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Computer Programming Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Cost-Benefit Analysis/ROI</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Environmental Applications</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Ethics Modeling</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Feedback Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Geospatial Data Processing Tools</td>
<td>Near Expert</td>
</tr>
<tr>
<td>GIS Theory and Applications</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Industry Understanding</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Leadership Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Model-Building Skills</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Photogrammetry</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Remote Sensing Theory and Applications</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Spatial Information Processing</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Systems Thinking</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Technical Writing</td>
<td>Near Expert</td>
</tr>
<tr>
<td>Technological Literacy</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Topology</td>
<td>Near Expert</td>
</tr>
</tbody>
</table>

### Ethical challenges

1. Maintaining appropriate confidentiality.
2. Protecting all intellectual property.
3. Ensuring truth in claims, data, and recommendations.
4. Recommending solutions appropriate for the customers’ or users’ needs.
5. Making misleading claims regarding return-on-investment.
6. Using client information for personal gain.
7. Falsifying data.
8. Protecting the integrity of all data.