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GEOSPATIAL WORKFORCE TRAINING AND DEVELOPMENT: BUILDING TOMORROW'S WORKFORCE FOR SPATIAL INFORMATION TECHNOLOGIES

Abstract: The National Workforce Development Education and Training Initiative, sponsored by NASA's John C. Stennis Space Center is a national initiative addressing the preparedness of the U.S. geospatial workforce. In response to an increase in the number of skilled workers needed to sustain the geospatial workplace, the Geospatial Technology Competency Model© was developed to articulate the kinds of workers needed in the geospatial information technology industry.

INTRODUCTION

The National Workforce Development Education and Training Initiative is being implemented by the Office of Education and the Earth Science Applications Directorate (formerly the Commercial Remote Sensing Program) at the NASA John C. Stennis Space Center. 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 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.

THE NEED

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).

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

DEVELOPING MODELS FOR PERFORMANCE IN THE WORKPLACE

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. Even the job of managers changes in such situations, for they must serve their project teams as facilitators, gatherers of resources, and removers of

roadblocks (Mathis & Jackson, 2000). The basis for recruiting, selecting, and compensating individuals is 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.

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 "should" performance for a specific position or job cluster.

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 perhaps have more durability (Bohlander, Scott & Sherman, 2001).

The Geospatial Technology Competency Model© developed at The University of Southern Mississippi most importantly provides a way to articulate the kinds of workers needed in the 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. Finally, the GTCM© offers a research framework for training providers and academic institutions to use for creating the most effective and efficient training and education opportunities.

DEVELOPING THE GEOSPATIAL TECHNOLOGY COMPETENCY MODEL©

In order for a competency model to have meaning and relevance for those who will ultimately use it, industry stakeholders must be involved. Geospatial technology industry stakeholders were involved from the beginning to help guide competency model development. The early involvement 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. This effort helped structure activities for focus group participants who were considered industry stakeholders and who were representatives of the following organizations:

- American Society for Photogrammetry and Remote Sensing
- Environmental Protection Agency
- ESRI
- Federal Emergency and Management Agency
- Geospatial Information Technologies Association
- Louisiana Department of Environmental Quality
- National State Geographic Information Council
- Naval Oceanographic Office
- Pennsylvania Department of Military and Veterans Affairs
- Spatial Technologies Industry Association
- University Consortium for GIS
- Urban and Regional Information Systems Association
- U. S. Department of Interior

- U. S. Department of Labor

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. An effort to include companies from across the United States yielded over fifteen major cities represented in the study. Employees from over twenty-eight companies participated in the competency model development.

Industry definition. A definition was written by industry stakeholders early in the process to ensure participants answered questions from the same industry perspective. Consensus was reached among focus group participants 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.*

The real heart and soul of the Geospatial Technology Competency Model© are the roles, competencies, and outputs for geospatial work. A *competency* is defined as the knowledge, skills, and abilities an individual needs to do their job. A *role* is not a job description, rather it is a grouping of competencies targeted to meet specific expectations of a job or function. An *output* is a product or service that an employee or group of employees delivers to customers, clients, colleagues, or coworkers.

Geospatial Roles and Role Definitions. Twelve distinct work roles were identified for the geospatial technology industry.

Applications Development – Identify and develop tools and instruments to satisfy customer needs.
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.
Coordination – Inter-organizational facilitation and communication.

Competencies. Four categories of geospatial technology competencies were identified as the required knowledge, skills, and abilities to function in each of the twelve 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 shown in bold. For a breakdown of the competencies by role, visit http://www.geowdc.usm.edu.

Outputs (deliverables) and Quality Requirements. In addition to identifying twelve roles, the key products or services (outputs) resulting from the work in each role were identified. The GeoWDC website, http://www.geowdc.usm.edu, provides the outputs for each role and the associated quality requirements for each output.

Table 1
Geospatial Technology Competency Model©

Technical Competencies	**Business Competencies**
Ability to Assess Relationships Among Geospatial Technologies Cartography Computer Programming Skills Environmental Applications **GIS Theory and Applications** Geology Applications Geospatial Data Processing Tools Photogrammetry Remote Sensing Theory and Applications Spatial Information Processing **Technical Writing** **Technological Literacy** Topology	**Ability to see the "Big Picture** Business Understanding Buy-in/Advocacy **Change Management:** **Cost Benefit Analysis / ROI** Ethics Modeling Industry Understanding Legal Understanding Organization Understanding Performance Analysis and Evaluation **Visioning**
Analytical Competencies	**Interpersonal Competencies**
Creative Thinking Knowledge Management: Model Building Skills **Problem-Solving Skills** Research Skill Systems Thinking	Coaching **Communication** Conflict Management: **Feedback Skills** Group Process Understanding **Leadership Skills** Questioning **Relationship Building Skills** **Self-Knowledge / Self-Management**

Note: Core competencies shown above in bold.

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.

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