Grazer Schriften der Geographie und Raumforschung **Band 43 / 2007** pp. 265 - 272

An Integrated Design of a Geospatial Program with an Information Technology Core

Randall L. Jones, James O. Brumfield, Michael Little, Juan de Dios Barrios, John Northeimer, and Ronald Quillin
Marshall Community and Technical College, Huntington, USA

Abstract

This paper addresses, firstly, the problem of an inadequately educated, trained, research-oriented geospatial workforce; secondly, support systems that provide geospatial-based workforce and economic development nationally and internationally; thirdly, multidisciplinary multilevel geobiophysical sciences and technologies using remote systems (RS) geographic information systems (GIS), and global positioning systems (GPS) with image-based modeling and mapping; and fourthly, information technologies and repositories of geospatial data needed by government, academic, and private sector economic entities. A group of processes have been envisioned, designed, and implemented in the formulation of flexible multidiscipline multilevel education, training, and research programs.

The learner of geospatial education and training is offered flexible opportunities to learn. This flexibility is represented by scalable knowledge base and skills from the associate through the post-doctoral degree levels. This is founded on learner self-study, formal courses, workshops and seminars, through life long continuing education processes. This learner's knowledge and skill based program has been designed and implemented to facilitate workforce and economic development through five supporting processes. The Learner's knowledge base and skills involve education and training, information resources and research, research and development, operations and technical services, and process management in a regional, national, and international arena.

Broader impacts of this integrated multidisciplinary, multilevel program include an expansion of geospatial knowledge and skills into the curricula of secondary schools, community and technical colleges, universities, private sector, and governments. This results in five processes involving geospatial computerized environment, of workforce and economic development.

Key to the success of the program are articulation agreements that facilitate a seamless transition featuring multiple exit and reentry points for the workforce with the various economic sectors. Threads of associate, bachelor's, and master's level geospatial programs are extant among several campus departments at Marshall University. These threads continue to be woven into flexibly organized multidisciplinary, multilevel curricula through the postdoctoral levels of learning. This provides the learner the geospatial knowledge and skills to begin in the public secondary educational system and to continue through advanced levels of education, training, and research as a lifelong set of processes through an international arena.

1. Statement of the Problem

The problem proposes the current inadequacy of further knowledge and skill-based development of an international geospatial multidisciplinary, multilevel set of processes and programs. These processes and programs are needed to support the learner of geospatial multidisciplinary, multilevel knowledge and training incorporating geographic information systems (GIS), global positioning systems (GPS), and remote systems (RS) with an emphasis on image-based modeling and mapping and information technologies. These flexible self-study opportunities are needed to learn scalable education from the associate level through the post-doctorate level, such as customized workshops, seminars, practicum and internships, capstone reviews, thesis, dissertation, and publication. These processes and programs are needed to enhance synergism of workforce and economic development through support processes providing education, training, pure and applied research, and skill development as well as information technologies and repositories of geospatial data needed by government and economic entities (Fig. 1).

Currently, the Universities and Colleges of the West Virginia Systems (Six State Universities and thirty plus of the four-year and two-year colleges) have mostly traditional programs in many of the standard disciplines. The products of these disciplines are encouraged to seek and solve problems within the discipline rather than crossing discipline boundaries.

2. Proposed Solution to the Problem

A flexible multidiscipline, multilevel solution is proposed as an academic extension to an existing program, Geobiophysical Modeling, at the Master of Science degree level (1,2). This program involves problem solving across the disciplines physically modeling the earth and life. A flexible international multidiscipline, multilevel education, training and research group of processes in an institute, such as the Nick J. Rahall, II, Appalachian Transportation Institute (RTI), with a focus on national transportation systems, is being developed. An International Geospatial Institute in strategic implementation planning is envisioned as a collective umbrella for organizing geospatial science and technologies. These international geospatial institute processes located in the University of West Virginia System of Marshall University which further encourages and facilitates integration of the scientific, engineering, technical, and social science disciplines and processes. The extension of this program-across-the-disciplines approach to problem solving on an international scale is further expanded to workforce and economic development with co-

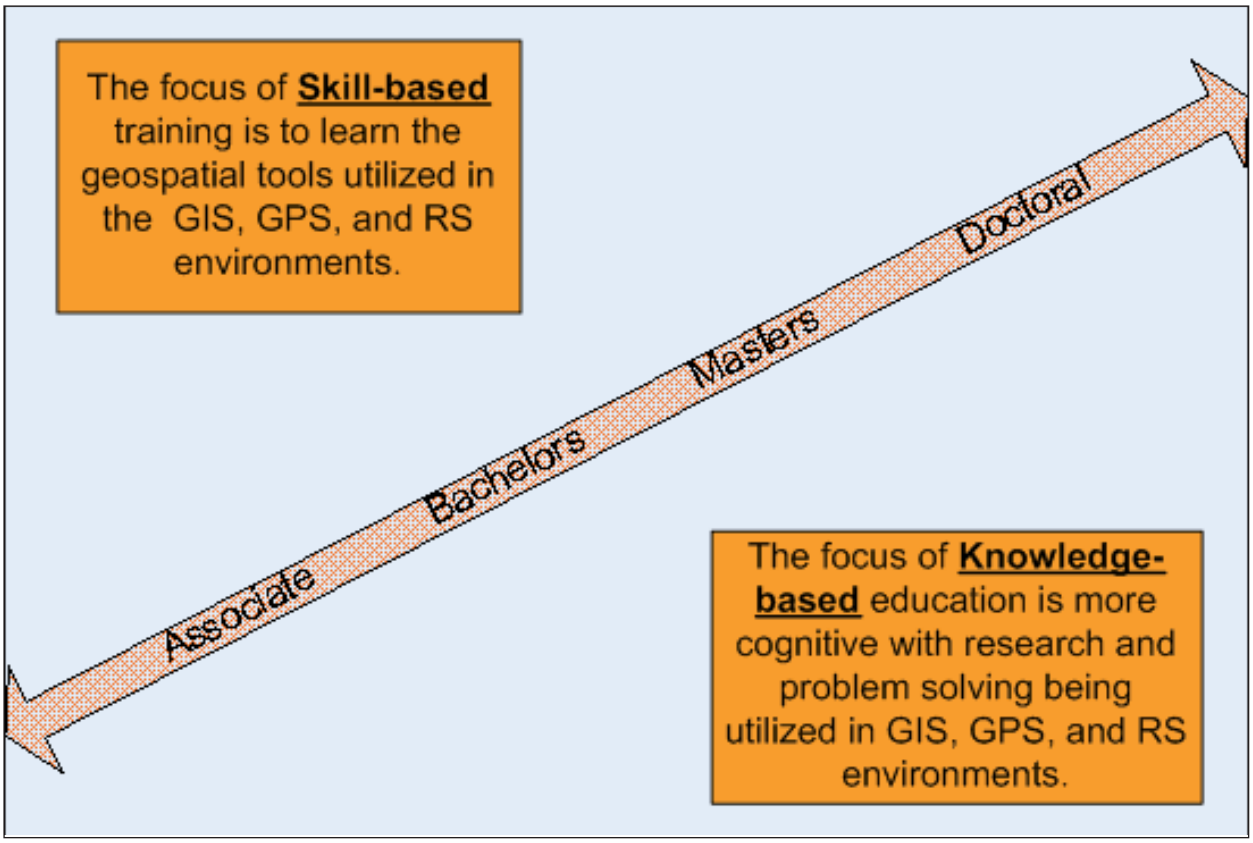

Figure 1: Skill versus Knowledge – Academic Degree Relationship.

operative multidiscipline multilevel program facilitation envisioned, as for example, with the Russian and Kyrgyz Academies of Sciences.

The extant program utilizes computer science and information technologies based in sophisticated image processing, geographic information systems with global positioning systems software such as ERMapper, ESRI, and IDRISI as integrated packages (9,10, 11). The Geobiophysical Modeling Program is currently illustrated by a cooperative curriculum in the remote sensing, geographic information systems, and global positioning systems in image based mapping with geobiophysical analysis and modeling for an emphasis in geospatial science and technologies. Marshall Community and Technical College, The Board of Regents Degree Program, and the Marshall University academic units, which includes the College of Science, Integrated Science and Technology, Information Technology and Engineering, and the Graduate College, have course offerings that are being formed into a geospatial 2+2+2+2+2 multidisciplinary program of continuing education at all levels of academic pursuant in degree or non-degree knowledge-based learning (1,2,3). There has, in the past seven years, been developed a master's degree program Master of Science in Physical Science in Geobiophysical Modeling, with areas of emphasis officially indicated on transcripts. This program draws heavily from discipline areas of physics, geology, geography, biology, anthropology, environmental science, environmental engineering, computer science, information technologies, and integrated science and technology. This interdisciplinary Master of Science in Physical Science in Geobiophysical Modeling Program emphasizes physical problem solving across the disciplines while the Bachelor of Science in Integrated Science and Technology has the problem solving with the framework of each multidiscipline course with the capstone experience providing the blend (2). Undergraduate and graduate curricula alike focus on solving real world problems utilizing remote sensing and geographic information systems, science, engineering, and information technologies with Earth Resources and Anthropogenic interactions involving the geo-sphere, hydrosphere, and atmosphere (2,3). These programs have grown rapidly since their inception with expanded undergraduate and graduate offerings in the past few years. The opportunity of enhancing education, training, and research processes while interfacing with the workforce and helping to generate new ideas, services, and products in the workplace promotes economic development.

Further, in the past three years, undergraduate and graduate components from the two-year Community and Technical College through the Graduate College of Marshall University with these academic disciplines, particularly in sciences and technologies, are developing processes to facilitate and enhance multidiscipline, multilevel field and laboratory sciences, and technologies (1,2,3). The Nick J. Rahall II Appalachian Transportation Institute (RTI) is assisting in providing infrastructure for research and development with related funding, matching dollar for dollar amount in research, education, and training for workforce and economic development (4). These education, training, and research processes are further enhanced through a geospatial set of processes and programs on a global scale.

3. Rationale for a Geospatial Multidiscipline Processes and Programs to be Implemented in Appalachia

Southern West Virginia has lost over 10% per decade of her population in the 1980's and 1990"s in many of the counties. Education with science and technology innovation, an important backbone for workforce development, has been an important part of that loss of 25% per year of the young people, representing nearly seventeen years of education between the ages of 25 to 35, leaving the state, circa 1980's,1990's (5). The Kyrgyz Republic is reminiscent of this Region of Appalachia.

These types of processes and programs facilitate rebuilding the economic base and workforce of West Virginia and are applicable to other regions of the world with similar issues and problems. Part of the solution is collaborative agreements in the international arena with National Academies of Sciences and Universities, such as a U.S. Fulbright Scholar Award to the Kyrgyz Republic and Russia.

The processes and programs being designed and developed are multilevel and multidiscipline approaches to problem solving in a flexible academic environment. Bright young people concentrating on multidiscipline, multilevel pure science, research, and applied technology projects for planned community development, transportation systems, and the environment provide that link to workforce and economic development. One such project, in southern West Virginia, being initiated for workforce and economic development is mountain top removal, bench formation, and surface mine reclamation providing community market connective roadway infrastructure. This infrastructure allows mountain-top housing and supporting community development above the flood plain where floods annually inundate and destroy properties and the quality of life for the people. Transportation networks and nodal placement of planned communities can provide infrastructure for increased quality of life for counties in southern West Virginia as well as the Kyrgyz Republic. This plan is predicated on dedicated bright and highly educated people to fuel the process. Such a community development plan

with developing infrastructure is being initiated in Mingo County of West Virginia limited partnering project agreements with the Nick J. Rahall Transportation Institute (6). This is a national model for Appalachia with international applications.

An extant RTI and Integrated Science and Technology Project focuses on transportation effects on selected living systems in the Ohio River, over 900 miles in length, and its tributaries. The third largest transportation tonnage port is the Port of Huntington (WV) and the location of Marshall University on the Ohio River System in the United States of America. The Channel is maintained at twelve feet by dredging and a series of locks and roller dams designed, built, and maintained by the U. S. Corps of Engineers, Huntington District.

This scientific and technological geospatial project is designed and implemented to access the life-form condition baseline on the Ohio River System. The focus is on transportation disturbance of the Benthic, mussel, and fish communities and their habitat in establishing a baseline database using geospatial science and technologies for concurrent geographic information system mapping and modeling. This includes remote sensing using side scan profile sonar and sampling of river bottom biological and physical composition with global positioning system and geographic information system mapping and modeling(4). This is another national model for Appalachia with international applications.

This illustrates a major need for education, training and research involving learner interaction in a peer learning environment through all educational levels in a lifelong learning experience(1). Educational and training improvements facilitates peer learning by the undergraduate interacting with the graduate learner on solving problems with projects as in the Master of Physical Science in Geobiophysical Modeling program. Graduates from this program have achieved national recognition from the U. S. Department of Transportation Research Office. Other graduates are successfully competitive for jobs with national and international entities, such as Columbia Energy Group, British Petroleum, ESRI, and U. S. Corps of Engineers (1).

Successes at the Master's Degree have reinforced the need for flexible multilevel, multidisciplinary education, training, and research environment. The additional opportunities of two-year increments of education, training, and research provide continuity of multidiscipline, multilevel peer learning and development. The increments allow 'stop-out' real-world experience while working with academia, industry, and government as part of the workforce. These flexible programs are supported through grants, research, and projects in which the learner has as a part of his educational lifelong learning processes. The Nick J. Rahall II Appalachian Transportation Institute and an international geospatial education, training, and research infrastructure, such as the International Geospatial Institute processes, with dollar match, can further facilitate peer learning and networking at all levels. A recent survey by the Geospatial Advisory Committee of these sectors indicates the need to add program levels to the expertise in remote sensing, geographic information systems, and global positioning systems for image based mapping (6).

This provides a proven set of lifelong learning experiences that continue to feed the educational processes of the person, the institute group, the university system, and institutes such as RTI or an international geospatial institute. These programs are being developed across the discipline, nationally and internationally, at all levels of education, training, and research, which includes tutorial discussion methods patterned after the University of Oxford and the innovative research methods of the University of Cambridge and/or European Universities modular infrastructure enhanced with practicum and internships.

4. The International Geospatial Institute and Program Process Infrastructure

Broader impacts of the processes and programs lay in a Phase I expansion of geospatial knowledge and skills into the science and technology curricula of secondary schools, the workplace, and government, resulting in an increase in trained geospatial technicians and professionals at all levels. A Phase II strategic implementation incorporates an avenue to obtain geospatial knowledge and skills in multidiscipline, multilevel environments.

Germane to the success of the processes and programs are articulation agreements to facilitate a seamless transition featuring multiple exit and reentry points for students and professionals (1,2,3). While threads of associate, bachelor's, and master's level geospatial programs are extant among several campus departments at Marshall University, these threads have yet to be woven into a flexible organized curriculum that would provide learner's geospatial education, training, and research beginning in the public high school. These processes will continue through education workshops leading to proficiency certificates, two-year transfer options, undergraduate, graduate, and postdoctoral geospatial processes. Existing and developing academic components into a flexible organized education and training program at the high school, workforce training level, associate degree, bachelor's, master's, and doctoral degree levels are being integrated. The merit of this project lies in the adaptation of a geospatial curriculum to processes and programs providing flexibility to learner in terms of time, place, and pace of learning.

Phase I - The diagram identified in Fig. 2 is a visual repre-

sentation of the component elements that come together to support the project that is being undertaken. Negotiations are underway with the four-year undergraduate Integrated Science and Technology Program to facilitate an articulation agreement with the two-year programs.

cational programs to facilitate geospatial science and technology transfer to the local, regional, national, and international economy.

- Information Resource and Research processes (IRR) – provide scientific and technical consulting services to

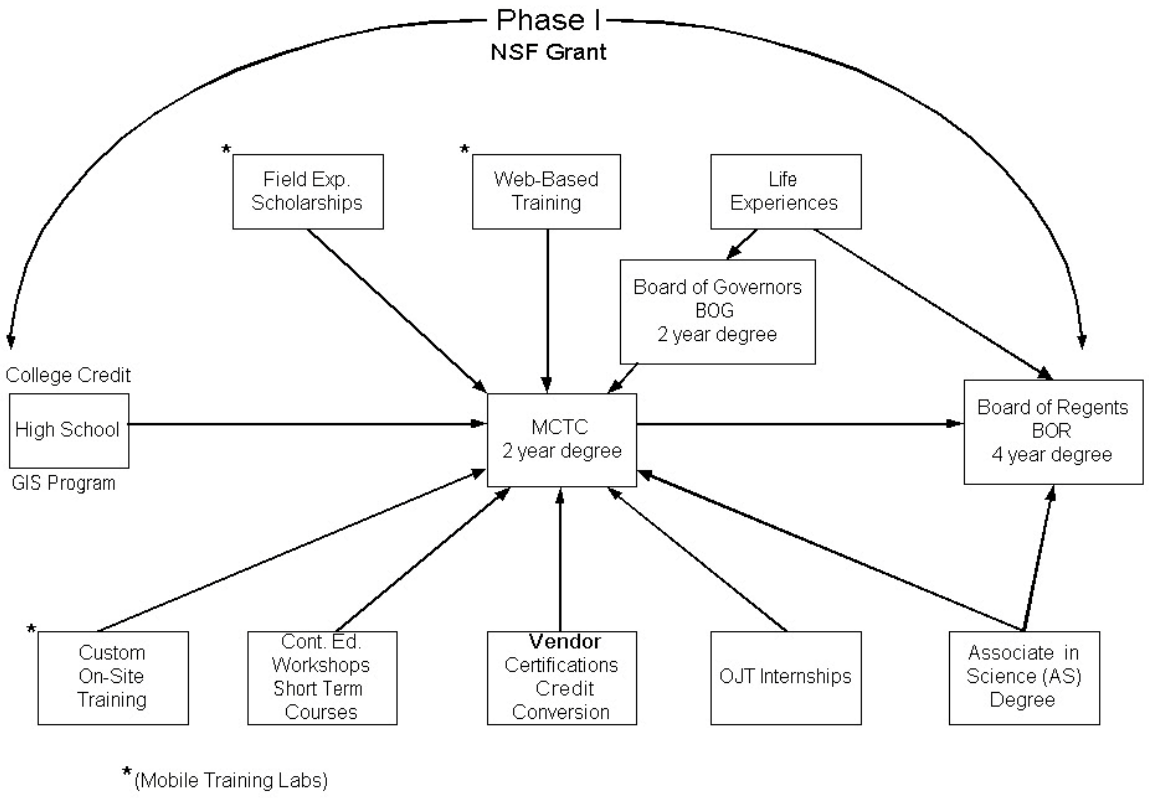

Figure 2: Phase I Structure .

Phase II - Multidisciplinary and multilevel programs of study are being concurrently developed that bring together the associate, bachelor's, master's, and doctoral degrees (Fig. 3). An International Geospatial Institute consists of five interrelated processes: Education and Training, Research and Development, Information Resource and Research, Operations and Technical Service, and Management (5).

Phase II implementation results in the development of a flexible organization with four functional processes under the direction of process management. It is flexibly organized to encourage the free flow of information within and among the various processes (Fig. 4). These processes are:

- Education and Training processes (ET) – provide continuing education training, retraining, internships, residences, as well as undergraduate and graduate education programs to facilitate geospatial science and technology transfer to the local, regional, national, and international economy.
- Information Resource and Research processes (IRR) – provide scientific and technical consulting services to academia, business and industry, and government to promote economic development. This process provides image data resources through an image web server to the repository.
- Operations and Technical Service processes (OTS) – provide expertise in answering queries from academia, business and industry, and government regarding GIS, GPS, and Remote Sensing applications. It supports the technology needs of the processes.
- Research and Development processes (RD) – explore the research and development of image-based mapping and modeling geospatial technologies to the application of real-world solutions with the implication to promote economic development.
- Management processes (MGT) – are designed and strategically implemented to encourage the free flow of information within and among the various processes.

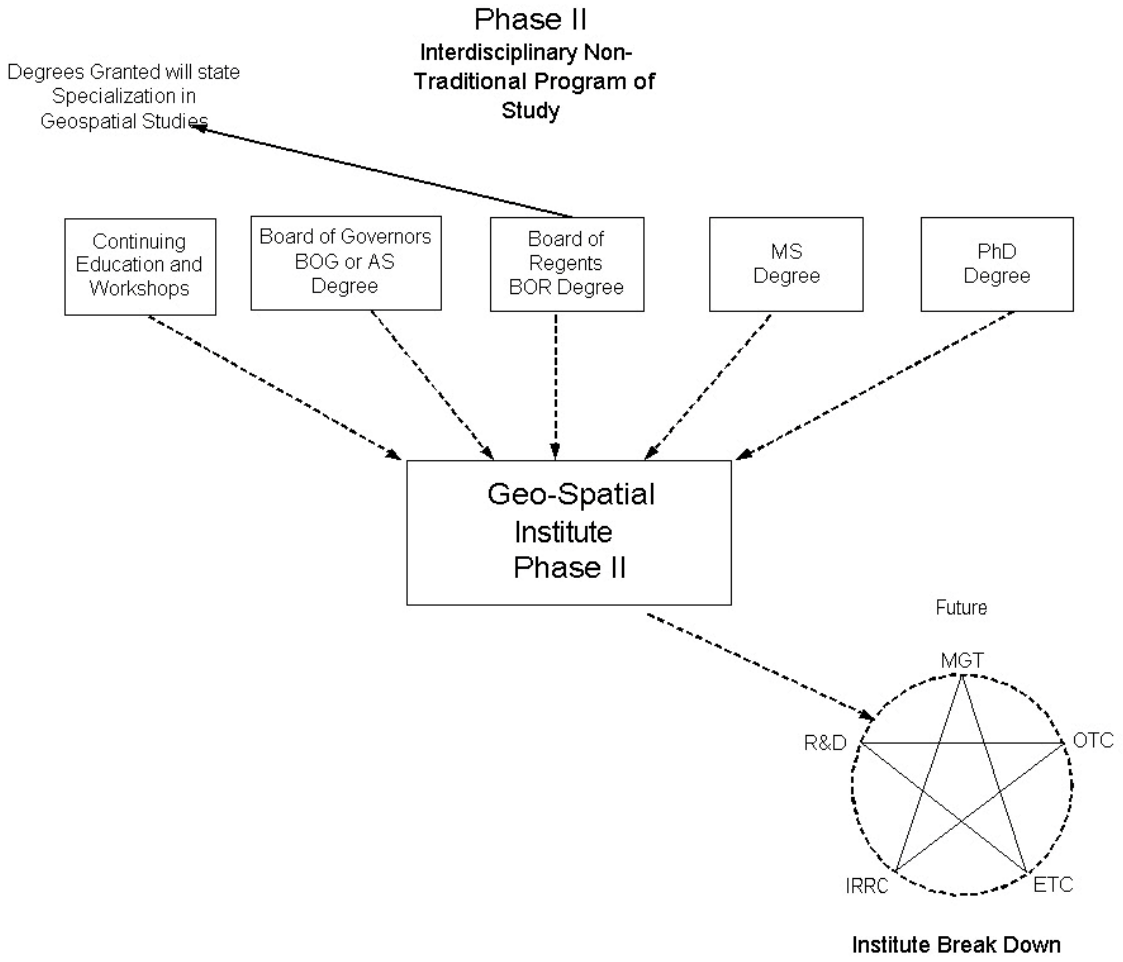

Figure 3: Phase II International Geospatial Institute .

5. Conclusions

Any education and training program implemented at any institution of higher learning needs to be capable of accreditation by the appropriate association of that institution. The program infrastructure being developed in this paper is education, research, experimentation, and training enhanced by process and organization. The challenge is to emulate this unique format, which encourages the development of individualized programs of study offering flexibility in meeting educational requirements, while adhering to the highest intellectual and educational standards. The rationale for following the main venue of this program provides a proven flexible infrastructure demonstrating excellence. Designed and developed for self-motivated learners ready to assume a significant measure of personal responsibility for planning their learning processes, this program of processes is individualized and built on previous learning as is the Master of Science Degree in Physical Science in Geobiophysical Modeling. Knowledge is gained through a wide variety of learning resources under the guidance and evaluation of highly qualified faculty members. Therefore it is preferable to refer to these self-motivated adults as learners.

Learners within these degree programs necessarily have several things in common:

- The desire and personal commitment to engage in additional learning that builds upon previously acquired learning and leads to the award of the degree
- Sufficient self-motivation to pursue a self-designed program
- The ability to use learning opportunities effectively wherever and whenever they occur
- Recognition of the responsibility of scholars to make a contribution to society
- A need to consider topics of interest from more than one disciplinary perspective
- An international viewpoint
- The learning aspects of the product demonstrating excellence, e.g., the capstone experience and review,

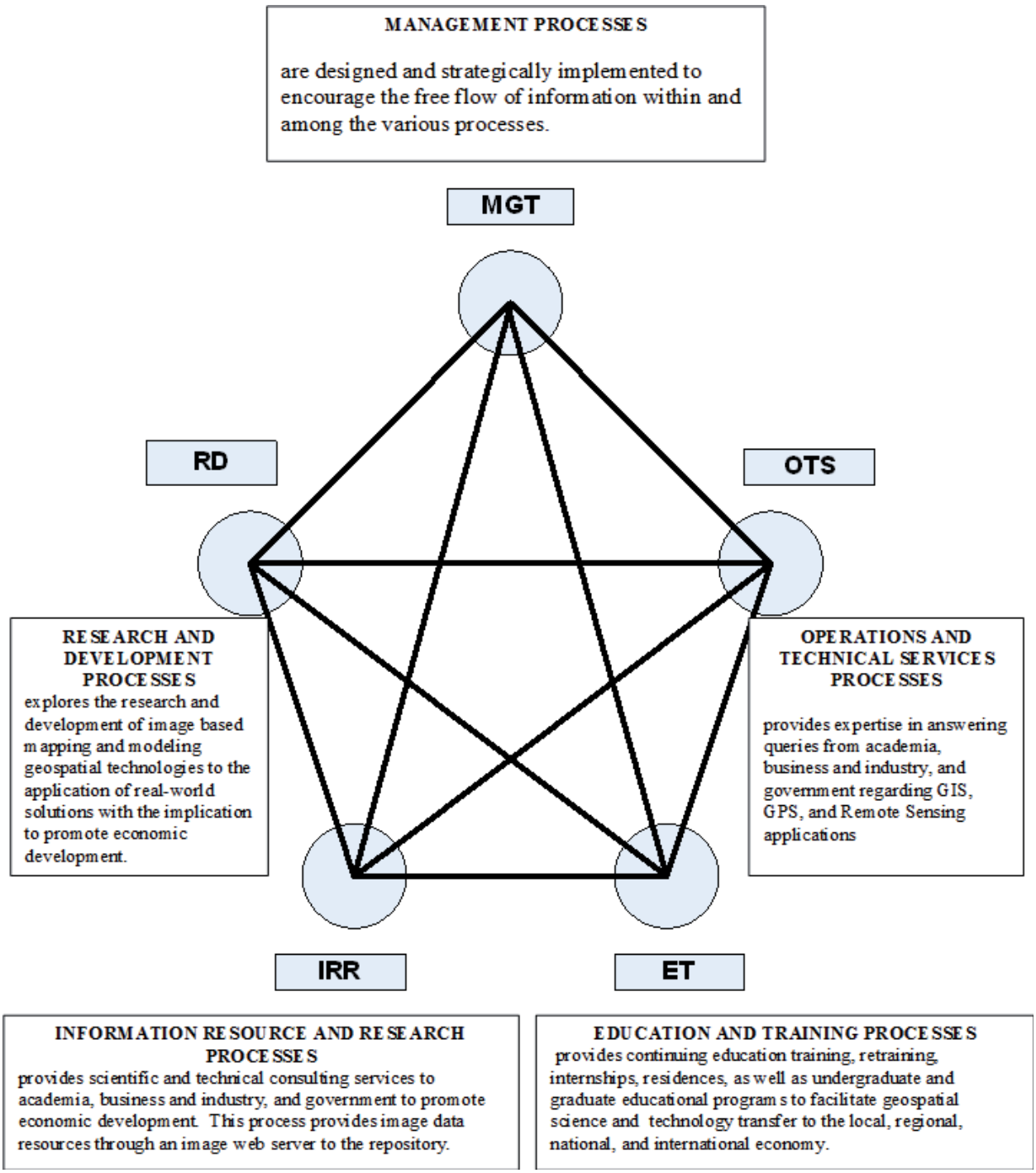

Figure 4: International Geospatial Institute.

thesis, or dissertation demonstrated and applied in a learner internship and practicum of at least three months' duration.

- Geospatial methods must be employed in the product demonstrating excellence
- The learner assists the advisor in organizing the Learning Agreement of his program and presents the Learning Agreement for certification by written signatures
- The learner must produce a written program summary of all learner program activities, learning processes, components, and justification/defense of the program
- Final defense includes the product demonstrating excellence and the program summary

The formation of Marshall University multidisciplinary and multilevel education, training, and research processes and programs is further enhanced by organizations such as the Nick J. Rahall II Appalachian Transportation Institute. The Nick J. Rahall II Appalachian Transportation Institute RTI is a National University Transportation Center, established under a grant of the US Department of Transportation, providing an opportunity to formulate some of the necessary infrastructure for this multidisciplinary program. The processes and programs need the multidiscipline and multilevel education, training, and research to provide the synergistic integration of government, private sector, and education academic units. The flexible multidisciplinary and multilevel geospatial programs are needed to provide synergistic peer learning and education, training, and research facilitation of the processes and programs. The flexible infrastructure is needed for facilitation of geospatial processes and programs. A number of science, engineering, technology, liberal arts, and graduate faculty have served on accredited program curriculum committees at other institutions and here. The faculty can bring these experiences to the program development of a facilitated flexible geospatial multidisciplinary and multilevel program.

The multidiscipline and multilevel education, training, and research with application of theory across the disciplines by applied research and practicum can accomplish these goals. These goals, summarized as solutions, are addressing:

- the problem of an inadequately trained geospatial workforce,
- inadequate support systems that provide geospatial based workforce and economic development with expanded opportunities.
- the utilization of multidisciplinary and multilevel geobiophysical sciences and technologies using Remote Systems (RS) Geographic Information Systems (GIS), and Global Positioning Systems (GPS) with image-based modeling and mapping,
- and, providing information technologies and repositories of geospatial data needed by government, academic, and private sector economic entities.

These solutions are incorporated as an integral part of each learner's multidiscipline and multilevel program of learning processes in lifelong development to be a more productive member of society. These processes are the beginning.

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Correspondence to:
Randall L. Jones
James O. Brumfield
Michael Little
Juan de Dios Barrios
John Northeimer
Ronald Quillin
Marshall Community and Technical College
1 John Marshall Drive, 25755, Huntington, West Virginia, US
e-mail: jonesr@marshall.edu
e-mail: northeimer@marshall.edu
e-mail: quillen@marshall.edu