Opportunities in the Commercial Uses of Remote Sensing and GIS Technologies: An Overview of NASA's Visiting Investigator Program at Stennis Space Center

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The lack of understanding concerning the value of remote sensing data to U.S. industry is widespread. Even as sales of remote sensing data are increasing on a yearly basis, the largest market for these data is still the U.S. government (Asker, 1992). NASA's Office of Commercial Programs has addressed this slow commercial growth with several innovative agreement mechanisms and commercial program opportunities. The intent is to enable industry in the use of remote sensing technology through shared risk ventures.

The Visiting Investigator Program (VIP), developed at Stennis Space Center's Science and Technology Laboratory (STL), provides a no-risk opportunity for industry to utilize the specialized resources at STL in an effort to incorporate remote sensing and GIS technology into their commercial operations. Through the VIP, industry can investigate technology which could lead to new commercial products, processes, or improved services that could benefit the company, the public, and NASA. This paper presents an overview of NASA's commercial remote sensing opportunities and highlights the VIP program and the results of a recently completed VIP project.

The use of remote sensing technology by U.S. industry has progressed too slowly. This is due in part to the lack of understanding concerning the value of remote sensing data to industry. Although every state in our nation offers some formal education in the use of remote sensing, the integration of this technology by new companies seeking to open new markets or improve existing product lines is relatively rate. This may be due in part to a lack of corporate understanding concerning the applications and potential benefits of remote sensing to an industry's product or service. Whatever the reason, it is apparent that barriers exist to industry's use of remote sensing technology as a viable source of information. These barriers range from the prohibitive costs of data and data analysis to a complete lack of knowledge concerning access to remote sensing data and its potential applications.

Barriers exist to industry's use of remote sensing technology as a viable source of information.

NASA offers a mechanism to break down these barriers providing industry a means to investigate remote sensing technology in a complete, front-to-end fashion from market determination and product definition through development, test, and evaluation. This mechanism would provide industry with the opportunity to investigate the application of remote sensing technology to their particular business. It has been noted that a key element to the integration of remote sensing technology into U.S. industry is the financial risk association with such an investigation. Therefore, this mechanism must include as a fundamental element a reduced financial risk for industry participation with the cost being shared by another industry or agency (Grey et al., 1987).

To provide industry access to shared risk ventures with U.S. government agencies, the National Aeronautics and Space Administration Office of Commercial Programs (OCP) has developed a program titled the Commercial Use of Space (CUS). This program is centered on the concept of joint venture relationships between NASA and private industry as a method of exposing U.S. industry to the commercial uses of space technology including remote sensing. This program is different from former NASA Technology Transfer programs in that it considers the whole process of how an in-

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dustry does business and the potential for remote sensing in that process. Early NASA Technology Transfer programs such as the Regional Application Program (RAP) were successful in transferring remote sensing data processing capabilities, but did not address the overall integration of this technology into the functions of the agencies they worked with. this resulted in varying degrees of success ranging from slow program start-up to program termination after NASA funding ended. The CUS program emphasizes a process designed to take joint venture partnerships between NASA and industry from application design to implementation. The goal of the CUS program, as it related to remote sensing, is to establish an aggressive commercial Earth observations program that results in increased U.S. industry competitiveness in national and international markets and industry placing its own sensor system in orbit in the 1990s. Strategic objectives related to this goal involve:

- providing a focal point within NASA OCP for U.S. commercial remote sensing ventures through the CUS Lead Center Program Office at Stennis Space Center;
- increasing commercial uses of space related to remote sensing for U.S. economic benefit;
- providing a conduit for communications between industry and program networks of NASA and other supporting federal agencies;
- protection of industry's proprietary research results; and
- reducing the technical and financial risk of private sector during new remote sensing venture development.

To accomplish these objective, NASA OCP has developed a number of innovative agreement mechanisms and programs which allow industry and NASA to cooperate with varying degrees of commitment. These range from a low investment of dollars and technology by each party to industry's ability to purchase NASA research facilities. Those agreements mechanisms in place for use in the CUS program at this time are discussed in the following paragraphs.

Memorandum of Understanding (MOU)—The MOU is a mechanism NASA uses to participate in a limited manner with any industry, university, or other organization. It is commonly employed when a formal declaration of cooperation is required by either organization and can serve to establish the basis on which further activity will be conducted. No money is exchanged in this agreement and research is usually limited to technical investigations and requirements definition.

Technical Exchange Agreement (TEA)—The TEA is used when both parties have parallel research programs in a particular technology and both would benefit from cooperation in this research. This agreement carries no monetary commitment by either party and is used to advance an industry into other areas of cooperative technology development with NASA.

Sponsored-Transfer Agreement (STA)—The STA is a mechanism whereby industry and NASA both commit money and/or technology to a project. The results of the project, including any developed technology, are shared by both industry and NASA. The STA is used when mutual goals of technology development are identified and proprietary rights to the results are not an issue.

Proprietary Work Agreement (PWA)—The PWA is designed to allow industry dedicated access to NASA research facilities. This is an innovative mechanism because industry pays a computed rate for access to specific government research facilities with proprietary rights to all results. This provides industry sophisticated research capability on new technology without incurring prohibitive start-up costs.

Joint Endeavor Agreement (JEA)—The JEA is a mechanism with "quid pro quo" arrangements arrangements for NASA. This means that both NASA and industry place equal resources at risk. This agreement is designed for industries which want to schedule a mission on the shuttle for the purpose of conducting an experiment or placing a payload in orbit. Under the terms of the JEA, industry supplied the flight experiment and NASA provides the launch capability. This agreement has a high degree of R&D associated with it, and both parties share the results of the experiment.

When entering into a working relationship with any industry, NASA officials determine the appropriate mechanism to use and develop the agreement for signature. This happens only after a careful evaluation of business objective, technical requirements, and legal issues. In many cases, one mechanism is used to evaluate an industry's potential use of remote sensing technology. At the conclusion of this evaluation, recommendations are made concerning follow-on work and appropriate manner to do so.

The Visiting Investigator Program (VIP) is part of the Office of Commercial Programs' mission to encourage the commercial development of space through the promotion of new space ventures and the development of new space technologies. The White House Executive Order of 10 april 1987, which

directs federal laboratories to engage in intergovernmental and private technology transfer agreements, has provided the most recent initiative for STL to develop the VIP. STL will support the selected visiting organizations by providing access to sophisticated facilities capable of a full range of remote sensing and image processing activities. STL's facility serves as a site for visiting scientists and engineers to conduct experiments as precursors to using other remote sensing facilities or establishing their own remote sensing capability. This space dedicated to this program is located within STL's main data processing facility and consists of high-end microcomputers and UNIX-based workstations using a variety of commercial and public domain software. By participating in this program, visiting investigators become familiar with the practical and theoretical basis for remote sensing, airborne data acquisition, related instrumentation, and data analysis techniques. The investigators work with NASA scientists in all aspects of planning the project from application, through analysis, to product development. As a result, remote sensing technology is brought closer to the goal of commercialization.

Remote sensing is brought closer to the goal of commercialization

The VIP, implement at SSC in FY88, is designed to offer and examination of remote sensing and GIS technology by U.S. industry on a no-cost, 90-day basis and, as such, serves as a catalyst for future work in other NASA commercial program opportunities. The VIP operates under a nonproprietary agreement that lasts from two to three months. If promising remote sensing science and application concepts are developed at STL, the potential exists for continued joint research efforts under other NASA Commercial Programs initiatives. The only cost to industry is the living expense of personnel while working at the NASA facility. A brief proposal describing the nature of the proposed research project is required. There are no deadlines associated with this program so proposals can be submitted at any time by qualified U.S. industries. A description of the research objectives and concepts to be explored is required along with a brief discussion of the commercial importance of the proposal. The research must be compatible with NASA's CEO program goals and present rationale for commercial implementation by the proposing industry. The research cost estimates for both NASA and the industry are also included. NASA's commitment of resources is negotiated on a project by project basis. Proposal review is carried out within two weeks of receipt by a qualified NASA team at SSC. Industries selected for VIP participation must enter into an agreement with NASA via a Memorandum of Agreement (MOA).

Smith Seckman Reid (SSR), Inc. is a consulting engineering company with five offices located mainly in the Southeast U.S. The company's primary activities center around civil and mechanical engineering applications. With the trend in population growth for the Southeast, SSR is looking for ways to increase their market share of the growing land use and environmental planning business. This is a logical extension to their existing residential and commercial design and industrial site development capability.

To expose SSR to the use of remote sensing and GIS technologies, a test area was selected near their Murfreesboro, Tennessee regional offices in Rutherford County, Tennessee, thirty miles southeast of Nashville. The project was designed to incorporate selected land use planning activities which SSR saw as opportunities for future contractual work. These focused on the development of digital databases, updating of existing digital databases and in particular, TIGER and DLG data, and change detection of land cover. Data acquired for this project included USGS Digital Elevation Model (DEM), Bureau of the Census TIGER data, SPOT panchromatic and multispectral data, and local utility network data. The data were spatially registered and organized within a GIS for analysis. The panchromatic remotely sensed data was read from tape media, geometrically rectified, and input in an unaltered form as an orthophoto basemap on which database construction was conducted.

A test area from within the larger geographic region was extracted and several image processing and spatial analytical techniques which would assist SSR in database development and information were investigated. Non-point pollution studies and non-point pollution impact assessment are areas of potential growth for SSR. Knowledge of land cover is fundamental to understanding non-point pollution potential for any given drainage basis, therefore, the SSR VIP project included traditional classification of multispectral remote sensing data. Supervised and unsupervised classification techniques were performed using a modified classification scheme developed by Smith Seckman Reid engineers. The classified data could now be integrated into a database containing drainage basin delineation, zoning, natural resource data, or other information used to determine impact on water quality.

Associated with water quality applications is the ability to conduct land use planning analysis and infrastructure database development and update. The Nashville region is a rapidly growing area and traditional methods of mapping are inadequate in representing the wide range of information needed to make informed land use planning decisions. State and local governments

are moving to the use of GIS technology to store map data in a digital format. The use of remotely sensed images to form an orthophoto basemap is an excellent alternative to traditional mapping techniques (Jensen, et al., 1990). Using remote sensing data, infrastructure and other features can be easily identified and mapped to a database through on-screen digitization. Using this technique, it is possible to update critical information by inserting a new image under the database "layers" and identifying the areas of change. A portion of the study area is shown in Figure 1, in which the transportation network derived from the TIGER data was revised using this technique to include new roads evident in the SPOT 10 metre panchromatic data.

Toward the close of their VIP project, SSR engineers identified an application which could benefit from the land cover classification and database development activity. The city of Murfreesboro was seeking approval to locate a spray irrigation facility as a means of handling treated waste water. The location of this facility was an ongoing project for SSR; however, a clear methodology for determining site selection had not been developed. After discussing the application and listing the siting criteria, NASA personnel assisted SSR in the development of specific map layers to assist in the facility location. These maps, derived from the classified data, were designed to eliminate from consideration environmental sensitive areas, or areas in close proximity to

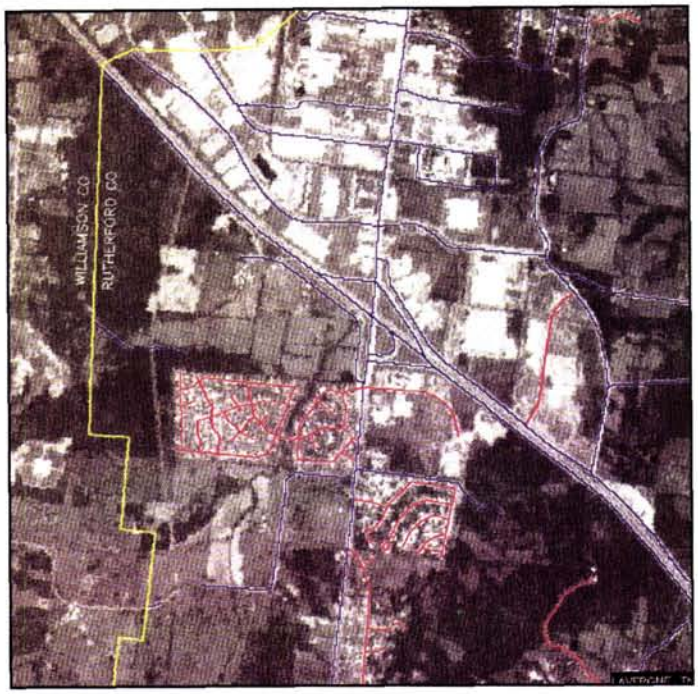

Figure 1.

certain land uses. The result was an initial siting map which SSR would use to harrow the selection possibilities (Figure 2). More importantly, however, what that this process provided SSR with a logical methodology to present to local government officials and concerned citizens.

Hardcopy products illustrating the applications developed during the VIP project were generated and the digital data loaded onto a portable microcomputer. NASA and the SSR personnel involved in the VIP project gave a joint briefing to SSR management describing the project and the possibilities for integrating remote sensing technology into the company's operation. This is a critical meeting form most VIP participants because mid-level managers or technical personnel normally initiate the company's VIP participation and must now bring the results to a management which will decide

The potential exists for continued joint research efforts.

Figure 2.

to continue using the technology and allocate the resources. For this reason, NASA attends these meetings and brings an image processing system and the data for the particular VIP project to demonstrate capability and answer questions. SSR management was very supportive of the project and, in particular, the spray irrigation application. Shortly after the presentation, the team involved in the project was given the authority to acquire image processing and GIS capability for SSR. Also, negotia-

tions were initiated with Middle Tennessee State University to utilize undergraduate students finishing academic training in remote sensing and GIS technology. These students would assist in ongoing projects and possibly move into full-time employee positions.

This case study demonstrates the concept of education through reduced risk, applications-oriented joint ventures between NASA and industry. SSR was give access to NASA facilities and personnel to investigate the usefulness of remote sensing technology to its own strategic business plan. SSR was not given a "canned" applications project nor shown a series of completed projects unrelated to their business. The VIP project was designed to test the remote sensing technology against SSR's current and projected business interests. This resulted in the development of several marketing products for SSR and the application of these data to an ongoing project. While the agreements and programs discussed here represent improved methods to encourage commercial participation in remote sensing technology, much remains to be done. New avenues for projects founded on partnerships between government and industry are needed to ensure U.S. industry's competitiveness in a world economy.

This case study demonstrates the concept of education through reduced risk joint ventures between NASA and industry.

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