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**JACKSON STATE UNIVERSITY'S
CENTER FOR SPATIAL DATA RESEARCH AND APPLICATIONS:
NEW FACILITIES AND NEW PARADIGMS**

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ABSTRACT

Jackson State University recently established the Center for Spatial Data Research and Applications, a Geographical Information Systems (GIS) and remote sensing laboratory. Taking advantage of new technologies and new directions in the spatial (geographic) sciences, JSU is building a Center of Excellence in Spatial Data Management. New opportunities for research, applications, and employment are emerging. GIS requires fundamental shifts and new demands in traditional computer science and geographic training. The Center is not merely another computer lab but is one setting the pace in a new applied frontier. GIS and its associated technologies are discussed.

The Center's facilities are described. An ARC/INFO GIS runs on a Vax mainframe, with numerous workstations. Image processing packages include ELAS, LIPS, VICAR, and ERDAS. A host of hardware and software peripherals are used in support. Numerous projects are underway, such as the construction of a Gulf of Mexico environmental data base, development of AI in image processing, a land use dynamics study of metropolitan Jackson, and others. A new academic interdisciplinary program in Spatial Data Management is under development, combining courses in Geography and Computer Science. The broad range of JSU's GIS and remote sensing activities is addressed. The impacts on changing paradigms in the university setting and in the professional world conclude the discussion.

THE JACKSON STATE UNIVERSITY CENTER FOR SPATIAL DATA RESEARCH AND APPLICATIONS: NEW FACILITIES AND NEW PARADIGMS

We are in an era of rapid technological change and few fields have seen such dynamic evolution as computer technology. Many disciplines are benefiting from the remarkable advances that are emerging, but the spatial (geographic) sciences seem to be profiting extraordinarily well. In particular, the new specialty of GIS (Geographical Information Systems) is experiencing an international growth of over thirty-five percent per year, which opens the door for new directions in research and applications and new markets for employment. Because of GIS, novel operational and philosophic paradigms are being introduced into numerous disciplines. Jackson State University (JSU) has embraced GIS technology and is developing a unique center of excellence in spatial data analysis and applications. This paper presents Jackson State's efforts and plans. A brief explanation of GIS and associated technologies is given, followed by discussion of JSU's GIS infrastructure and activities. Intrinsic in the presentation are the changes in educational, research, and applications directions that are arising from these technological advances. In particular, we emphasize the dynamic paradigms that are sure to have long-reaching influence in the profession. (Note: herein GIS refers to the broad range of computer spatial techniques and technologies rather than to a specific package of mapping routines.)

GIS and Remote Sensing

GIS is a computerized methodology for collection, organization, analysis, and display of geographic data. Far more than simple computer mapping it provides sophisticated techniques for manipulating geographic data. First, GIS is a spatial data base, an ideal inventory structure from which diverse forms of information can be stored and extracted. Any type of data that can be located ("georeferenced") can be used, e.g., maps, imagery, census information, etc. From there data can be extracted in "raw" form for direct readout or combined with other data sets to produce new information.

More important is the analytical capability of GIS, especially considering the graphics functions for mapping. Data from various scales and formats of maps can be combined (overlaid) to assess relationships previously impossible to determine. Buffer zones of select size can be built around features for proximity analysis. Many other "tricks" are available for manipulating data either graphically or within the data base. Each generation of data forms a new base from which to perform analysis.

Remote sensing imagery (photographic or digital) from aircraft or satellites forms an important data resource for GIS. Unlike traditional airphoto depositories where imagery is stored on rolls of film in canisters for occasional visual inspection, modern remote sensing techniques convert landscape scenes to digital format. Once in the computer, a plethora of processing procedures is available for extracting new information not perceivable in the original imagery.

Satellite data, for example, are obtained in several distinct bands or channels of the electromagnetic spectrum, each channel providing unique views of a scene. Digital manipulations can be applied to each band to derive a variety of data. When composited in different combinations, synergetic renditions can result. Many versions of the original imagery are obtainable.

GIS also has advantages for map production, e.g., ease, rapidity, and flexibility. Traditional pen and ink methods of cartography are too limiting in terms of time and design agility. For example, map size reproduction can be changed quickly and easily, typically via a simple computer instruction. Segments of the digital coverage can be separated and mapped. Also, the range of data to be used is selectable, from the full set (maximum discrimination) to a more simple (generalized) classification. Efficient and flexible productivity is a primary characteristic of GIS.

Other advantages are apparent. Statistical reports can be produced automatically, describing the quantitative and qualitative nature of each viewed feature. Map storage no longer needs physical equipment such as large cabinets or racks. Data can be shared over long distances rapidly, easily, and cost effectively. In effect, GIS offers highly efficient and flexible methods and technologies to innovate the spatial data world.

Jackson State University

Jackson State is developing a Center of Excellence in Spatial Data Management to take advantage of the many research and market opportunities afforded by GIS technology. JSU is particularly well-suited to such innovation because of several advantages: (1) Having considerable computation power, major GIS and remote sensing packages can be facilitated without additional expensive investment. (2) With a large computer science (CS) faculty, a substantial human resource base exists. (3) Having the largest computer science enrollment of any HBCU, an excellent student resource base and a foundation to establish an academic program are in place. This is particularly true given the extraordinary enthusiasm exhibited by students thus far.

(4) A relative vacuum exists in the state and region concerning GIS, thus giving an unparalleled opportunity to the institution having prescience. (5) Probably the most important factor has been the presence of an administration, from the top down, with remarkable foresight, ambition, vision, competence, and cooperation in emplacing a new direction in the university setting. Therefore, JSU is building a substantial and exceptional program in the new spatial technologies from which it can become a prominent and pace-setting leader.

Central to the center of excellence concept is JSU's new Center for Spatial Data Research and Applications (CSDRA). The CSDRA (also referred to as the Center) is a GIS and remote sensing lab providing the setting for research, educational, and professional out-reach efforts in the spatial sciences. Described below are its facilities and equipment, major research efforts, academic developments, professional activities, and plans.

Facilities, Equipment and Staff: Housed in the new science building, the CSDRA contains most of the GIS and remote sensing equipment. The nucleus of the GIS infrastructure is a Vax cluster ARC/INFO, the premier international system. It uses a powerful mapping graphics package integrated with a relational database program. Three Tektronix workstations serve as the primary interfaces, but numerous other graphics terminals are used as secondary workstations. Micro-based ERDAS is also used.

Image processing software consists of NASA's ELAS and LIPS, Jet Propulsion Laboratory's VICAR, and ERDAS, all functionally linked to ARC/INFO for direct feed of imagery to a mapping base. A 40" Calcomp color electrostatic plotter and two Tektronix color inkjet plotters serve as the primary hardcopy devices. Mapping data entry is performed on a large digitizing tablet and with an

Eikonix scanning digitizer. A host of peripheral equipment supports operations, e.g., microcomputers, film recorder, etc.

CSDRA staff consists of a principal investigator, Center director, lab manager, a project manager, five CS faculty, three systems technicians, and several clerical personnel. Twelve research assistants and four workstudy staff form the student help. The academic program (to be discussed) will be supported by two new faculty, one in computer science and the other in geography. Adjuncts from local GIS and remote sensing operation agencies serve as program associates.

Projects: Two major funded research projects, begun in late 1987, formed the initial and primary efforts of the Center. The Department of Interior's Minerals Management Service (MMS) initiated a project to develop GIS in its operations, to build a Gulf of Mexico environmental database, and to assist in various research and applications tasks. MMS is responsible for off-shore mineral leases and mineral extraction activities, so its basic duties are ideally suited to GIS methodologies.

The first task was to construct a lease block data base to serve as the base map and data for subsequent informational needs. Over 30,000 blocks are distributed in the Gulf and each has unique identifiers that must be quickly recalled and used either graphically or in the relational data base. GIS's ability to relate to either graphics or tabular data is a critical asset for MMS needs. Other MMS tasks include mapping of Alaska off-shore blocks and data, mapping of coral reefs and offshore structures, digitizing of shallow geology, and data base preparation to support oil spill accidents off Florida.

The National Aeronautics and Space Administration (NASA) has aimed primarily at image processing (IP) but is also interested in using remote sensing in support of GIS. One of the major projects is the inventory and analysis of metro Jackson, Mississippi urban dynamics—land use, demographic factors, quality of life, environmental impacts, and application of artificial intelligence (AI) and expert systems to identification of undeveloped lands. Remote sensing from NASA aircraft will cover the city with large and medium scale color infrared photography and digital scanner data. Imagery is the principal data source but associated contemporary and historic information is employed for comprehensive coverage.

Other NASA assignments consist of a variety of data conversion and programming tasks, publication of a nation-wide remote sensing facilities survey, assistance in development of an academic program and associated specialized training, construction of a publication data base to support numerous GIS and remote sensing needs, and provision of overall guidance in the establishment of the center of excellence. Other smaller projects are under consideration (see Plans below).

Academic Programs: One of the major new paradigms to emerge from GIS is the development of a truly interdisciplinary methodology in the spatial sciences. A new (Fall, 1990) interdisciplinary academic graduate and undergraduate program in Spatial Data Management (tentative title) is under development. The undergraduate program consists of courses in both the departments of Computer Science (Science and Technology Division) and Urban Affairs/Geography (Liberal Arts Division), forming a concentration in both disciplines. A graduate concentration in CS will be part of the information science direction. Courses in GIS, remote sensing, spatial analysis, and traditional applications and systems are used. Projects, theses, and an intern option provide practical experience. One thesis has been completed and two are underway. The JSU spatial data program is distinctive in the American university system in that it integrates two traditionally segregated departments—Geography and CS. Unique in HBCUs, JSU's GIS-based academic program is approached only by a very small number of higher education institutions. New directions and new educational paradigms are being

established. Both geographers and computer specialists must redefine their approaches to the management and analysis of spatial data, but the potential rewards can be tremendous.

Professional Activities: CSDRA personnel have been instrumental in instituting a state-wide alliance of GIS and spatial data users—the Mississippi GIS Association. It provides a linkage among academic, public, and private users of GIS or geographic data. A newsletter is to be published and several activities for community out-reach are planned, including surveys of systems and relevant data bases in the region. A coastal branch was begun recently and other divisions are under discussion.

Presentations and publications on several themes have been produced. Fundamentals of marine GIS were established. Future directions of GIS and associated fields, particularly the contributions of computer science advances, have been presented. A national survey of remote sensing has been published. Numerous papers have been given and several publications are in process.

Plans: Two other major projects are pending (summer initiation planned): economic mineral mapping of northeast Mississippi and institution of a county GIS operation. Additional small formal and informal research and applications activities are under discussion. For example, GIS is a perfect mechanism for design and creation of thematic atlases and a quality of life atlas for the state has been proposed.

Jackson State's GIS program has only begun and it is difficult to predict the specific directions that will be taken. The themes mentioned will continue to be important but other interests may be pursued. As expertise and capabilities build, one desirable direction is the application of GIS to Third World development, particularly Africa. Preliminary contacts with relevant agencies have begun, e.g., the United Nations Environmental Program's Global Resource Information Database (GRID).

Enhancement of the academic program has high priority. As the initial strategy develops, more depth will be added in terms of courses and faculty. New disciplines will be included. Equally important will be increased opportunities for student hands-on experience, either in the Center or in additional internship locations. Because GIS is a practical application, we feel that it is essential that properly trained graduates have functional credentials.

Purpose

As a progressive institution, JSU is interested in cutting-edge advances in many disciplines, but GIS is perhaps one of the most exciting and productive new fields to emerge from technologic progress. To embrace the GIS field is a logical and forward step in institutional evolution. To date, only a few schools offer training beyond an introductory course and broad, strong programs like the one at JSU are largely absent on the academic scene. However, the strengths, potential, and market for GIS is not a secret, for it has become entrenched in several disciplines in the last few years; it is only a matter of short time before analytical computer mapping becomes a standard curriculum item. By taking a lead at this relatively early stage, JSU stands to become broadly noted, not only among HBCUs, but on the national scene as well. That purpose alone suffices as relevant support for contemporary development of GIS at Jackson State.

The market potential for GIS-educated personnel is tremendous, especially given the very high growth rate of the field and shortage of qualified personnel. It takes little to become marketable today (usually a little experience or a course in GIS), but enhanced training (dedicated program with

specialized directions) will ensure high promise of professional success for graduating seniors or masters. This is specifically valid for minorities, who are vastly underrepresented in the field. Thus, marketability is a major purpose for initiating a center of excellence.

One of the primary reasons that GIS and its related fields are doing so well is that more and more types of data are becoming "spatialized", i.e., tagged to location. Once the locational attribute has been identified, GIS can apply its many capabilities to produce information heretofore unavailable. There is little wonder that sales of GIS software and hardware are increasing internationally at over thirty-five percent per year. This is another substantial support for JSU's activities.

Paradigms

As used here, "paradigm" denotes a model of thinking or acting, a philosophic or practical basis for operating in a prescribed manner, or a fundamental logic or motivation for development of values and social or professional behavior. Paradigms guide, often tell, how to proceed and what to expect. However, paradigms change—society evolves and ideas go through "life cycles", from birth and infancy through maturity to old age and eventually, death. Scientific paradigms are especially sensitive to technologic and social changes and may have relatively brief lives. Paradigms in computer science have rather particularly short life expectancies.

GIS is much more than a technologic advance; it is establishing new ways of doing new things with spatial data. New paradigms in scientific and social training, analysis, and applications are under construction. Disciplines and professions are undergoing radical transformations; change is inevitable. For example, as JSU's Geography program plans for reinvigoration of its techniques courses in preparation for the spatial data management concentration, a detailed budget must be furnished. The "shopping list" of cartographic supplies does not include drafting equipment, press-on lettering, or any of the paraphernalia commonly found in traditional mapping labs. We plan to begin at the digital level and build from there. The rationalization (i.e., new paradigm) is that the professional world is much more interested in modern training than in old style techniques.

Another paradigm under development is that no longer can a single discipline provide the necessary breadth that is demanded by employers today. The market is best for those who have both technical skills and a broad understanding of what to do with the new techniques. The most viable GIS training involves both operations and applications. We have accepted that premise and are designing programs to accommodate the CS major and the applications disciplines. There can be pockets of resistance in interdisciplinary or trans-divisional programs (the new paradigm), but the vision that is making JSU a leader in the field recognizes the necessity of different paths for different destinations.

Despite reluctance to overstate, it is difficult to exaggerate the potential that exists in this new approach to the use of geographic information. Jackson State University is at the forefront of initiating and instituting important new paradigms not only in the educational universe, but in the applications world. As an HBCU, JSU is responsible for an added dimension of substantiating the role and mission of minorities. The wealth of possibilities, the richness of potential, and the inevitability of new horizons are apparent; JSU intends to be at the front, providing avenues for all. Clearly, we are at an age of new paradigms.