
Centralized vs. Distributed Systems: Academic Library Models for GIS and Remote Sensing Activities on Campus

JOE AUFMUTH

ABSTRACT

Academic libraries are a prime example of an enterprise whose mission is to support the information needs of its institution. Geographic Information Systems (GIS) and remote sensing (RS) are popular topics for academic research and are used globally. Two major enterprise information service and data delivery models, centralized and distributed, describe how enterprises approach information sharing. Simply stated, centralized systems provide services and data through a single individual or departmental unit. Distributed systems rely on many interconnected individuals or units to supply services and data. There are advantages and disadvantages to both, which may lead to a hybrid model of combined elements or a movement away from one and toward the other. This article discusses centralized and distributed enterprise information service and data delivery models and how two Florida university libraries deploy these models to deliver enterprise GIS services and data to their institutions' user communities.

INTRODUCTION

Information services and data products such as those associated with Geographic Information Systems (GIS) and remote sensing (RS) are provided by many public and private organizations. By definition, "Any organization [public or private] that needs to support multiple concurrent users accessing a shared information resource" (Rich, Das, & Kroot, 2001) can be called an enterprise. The enterprise's concurrent users can be both internal and external to the organization. Academic libraries are a prime

example of an enterprise. If viewed in the context of an academic institution, one might even view libraries as an enterprise embedded in the larger institutional enterprise. At the academic institution level, administration, teaching, research, and technology transfer are intended to meet the information needs of concurrent users in society. Simultaneously, the people, information services, and materials physically owned or licensed virtually by the library directly support the mission and information needs of the academic institution, that is, faculty, staff, students, and others outside the institution. For the purposes of this article, GIS will be used to refer to both GIS and RS as combined spatial services and data.

ENTERPRISE GIS

An enterprise GIS is typically viewed as the infrastructure (hardware, software, and personnel), spatial data, and applications used to inventory, manage, and analyze an institution's own spatial resources. In "Developing Enterprise GIS for University Administration: Organizational and Strategic Considerations," McCormick discusses enterprise GIS for university administration (McCormick, 2003). He points out three GIS usage areas: technical reference (planning and facilities), public reference (cartographic visitor maps), and decision support (student recruiting, locating facilities, etc.). He also describes three scales of enterprise GIS usage: a single departmental GIS, which is created for a specific purpose; a loose confederation of departments, which might share spatial software and data; and a fully integrated enterprise system, which may even be used for detailed records management. The scale of enterprise usage may change due to success or failure at any one particular scale.

The literature reveals that McCormick's public reference category exists in academic libraries. Some articles have proposed GIS systems that provided patrons with collection location information (Xia, 2005), developed GIS interfaces to digital historic collections (Haas et al., 2005), and investigated geographical interfaces to catalog records (Haas, Aufmuth, Coleman, & Uhlinger, 2002). While GIS has been used to locate new public library facilities (Koontz & Jue, 2001), nothing in the literature suggests GIS is internally used in locating new academic library facilities, library facilities management (McCormick's technical reference), or library decision-making support.

SERVICE AND DATA DELIVERY MODELS

Two significant models for delivering an enterprise's information services and data are the centralized system and the distributed system. Simply stated, centralized systems provide services and data through a single individual or departmental unit. Distributed systems rely on many interconnected individuals or units to supply services and data. There are advantages and disadvantages to both that may lead to a hybrid model of combined

elements or a movement away from one and toward the other. For instance, the single point of access in a centralized system requires users to have a high level of trust in the provider's ability to meet user needs. A lack of trust may lead a department to develop its own GIS. In distributed systems some of the services and data delivery points may be redundant and lead to consolidation to reduce costs. In a hybrid system, some features of a distributed system may become centralized, such as software licensing for multiple users.

An academic library's choice of GIS service model is influenced by current campus-wide GIS activities—or "enterprise scale"—as defined by McCormick, as well as the library's willingness to compete with other centers on campus. Libraries at institutions without GIS research centers or GIS in academic departments might initially choose the centralized system and become the hub of campus GIS activity. The centralized model may start out in a collaborative mode, but as campus departments develop GIS expertise, libraries may find themselves competing for funding and space. If an established network of campus GIS and remote sensing research centers and programs already exists, libraries might choose to provide GIS services to faculty, staff, and students in those distributed departments rather than create its own center. In distributed systems the library can also serve as a neutral place for highly competitive research and educational centers to come together. Whether centralized or distributed, library GIS services and data delivery may include data acquisition (creation, download, or purchase), data processing and analysis, data distribution, data maintenance, data archiving (institutional repositories), GIS applications (development and/or implementation), software (purchasing, licensing, distribution, and installation), hardware support, teaching, research, and consulting.

A TALE OF TWO LIBRARIES

The State University System (SUS) of Florida has eleven member institutions. Many of the institutions have prominent GIS and RS teaching and research programs. Four of the institutions' academic libraries—University of Florida (UF), Florida International University (FIU), University of South Florida (USF), and University of Central Florida (UCF)—have hired or identified library faculty responsible for spatial data and services. All four libraries exhibit some traits of either the centralized or distributed models for enterprise GIS information services and data delivery. Although the traits are exhibited, the libraries did not plan to follow a specific model. Instead several factors have influenced the direction each has taken. Each university's history, breadth and depth of academic programs (McCormick's "scale of usage": single department, loose collection, or large-scale enterprise), and institutional culture helped shape library services to meet users' needs. Two of the SUS libraries that typify the centralized and distributed models are FIU and UF respectively.

Centralized Model: Florida International University

Florida International University, which celebrated its thirtieth anniversary in 2002, has been successfully growing academic GIS teaching and research programs. Library GIS and remote sensing services and data delivery at FIU have evolved from a one-person government documents department initiative in 1995 (formerly known as the Geographic Information Systems Remote Sensing Applications Laboratory, GISRSAL) to an autonomous full-service GIS and remote sensing library department and campus center, known as the GIS-RS Center. In the years between 1995 and 2000 GISRSAL was the only GIS and RS research and teaching laboratory on the FIU campus. All of the other departments on campus utilized the library's facilities. Over the ten-year period since 1995, the number of GIS-RS Center personnel has grown from a couple of individuals to six full-time individuals, including a GIS-RS Center Head who reports to the Director of Libraries, a GIS Research Manager, a Web Developer/GIS Programmer, two GIS Research Associates, an IT Administrator/Developer, and an IT Associate/Web Designer. The GIS-RS Center has an advisory committee consisting of thirteen individuals representing a total of nine departments and other campus centers with a vested interest in GIS and remote sensing. The committee advises the library administration and the Center Head on user community service needs and direction. Hardware listed on the center's Web site includes twelve staff computer workstations, forty-five teaching and research workstations, three Internet servers for applications and data, a fiber optic network, a large format scanner, a digitizing tablet, a color printer, and a large format plotter. Center software includes the Microsoft Office Suite; SAS for statistical analysis; and ArcGIS, ArcView, and Leica's ERDAS Imagine for GIS and remote sensing. The center also distributes and maintains campus-wide GIS software and licenses. In order to fiscally support the center's activities, a fee-based approach to services has been adopted. Fees charged for mapping and data analysis services are listed at \$50/hour for FIU students and \$75/hour for faculty and non-FIU affiliated patrons. Plotting charges vary by type and size of print. If print files need to be restructured to fit printer dimensions, an additional \$50/hour fee is charged. Faculty and other campus labs using the GIS and RS software are charged an annual software user fee, which includes the license, installation, and troubleshooting support. Software fees vary by application. Besides the typical GIS and RS services, the center actively pursues related grants, collaborates on research, participates in teaching GIS classes and labs, and coordinates a graduate GIS certificate.

The FIU GIS-RS mission statement summarizes campus GIS efforts and the center's centralized role:

GIS-RS Center at the FIU Green Library primarily supports all the computing and research needs in the areas of Geographic Information Systems, Remote Sensing, geo-statistical analysis and Computer-Aided

Design (CAD) for the FIU community. Consulting services include assistance with geographic information systems, data analysis and extraction, statistical software, scientific visualization and remote sensing software. We also provide training in the uses of desktop GIS programs and organize seminars and workshops in GIS. The GIS Center has two physical divisions, the Teaching Lab and the Research Lab. The High Performance Database Research Center, International Hurricane Center, South Florida Environment Research Program, FIU Department of Geology, Environmental Studies, and Landscape Architecture and Design all help to equip the lab with hardware, software and expertise enabling the center to fulfill its goals and objectives effectively. (FIU, 2006)

Distributed Model: University of Florida

The University of Florida, which recently celebrated its 150th anniversary, has an established history of conducting GIS and remote sensing activities on campus. In 1984 the Geo-Facilities Planning and Information Research Center (GeoPlan) was established. The College of Design, Construction, and Planning (formerly the College of Architecture), in response to UF's growing GIS research and teaching needs on campus, created GeoPlan in the Department of Urban and Regional Planning. The center is still very active today and serves as a spatial data node on the National Spatial Data Infrastructure (NSDI) network. GeoPlan is widely acknowledged throughout the state of Florida for the creation and maintenance of the Florida Geographic Data Library's (FGDL) 350+ GIS layers. FGDL grew out of a joint Florida Department of Environmental Protection (FDEP) grant project between the UF Map and Imagery Library and GeoPlan Center. Since 1989 various departments on campus have been conducting GIS and remote sensing activities. GIS and RS activities at UF span several colleges (Engineering, Architecture, Liberal Arts, and Agriculture), and research labs are distributed over many departments (Civil Engineering, Environmental Engineering, Computer Science, Electrical Engineering, Urban and Regional Planning, Landscape Architecture, Geology, Geography, Forestry, Botany, Wildlife, Soil Science, Food and Resource Economics, Entomology, Anthropology, and others). In the early 1990s UF became one of the first universities to have a university-wide Environmental Systems Research Institute (ESRI) ARC/INFO site license, and initially software license costs were shared by individual departments. In the late 1990s the UF provost's budget began paying for the license and GIS became freely available to all departments.

Prior to the late 1980s the approach to higher education at UF was to eliminate redundancy in academic courses and programs. If one program taught a subject or had an area of expertise, other programs on campus were discouraged from pursuing those same subjects. Between the late 1980s and mid- to late 1990s, a former university president implemented a business model approach to higher education. Colleges and departments

were rewarded for the number of class seats filled and the amount of research dollars in their laboratories.

The cultural shift, combined with freely available GIS software, resulted in a surge of GIS and RS courses and research efforts on campus as well as fierce competition between colleges and departments. GIS evolved as a significant focus in many disciplines, and some departments sought recognition as UF's expert. The constant competition caused a former provost to create UF's Interdisciplinary Concentration in GIS (ICGIS) Committee and graduate-level certificate program. Because the Head Map and Imagery Librarian and the GIS Librarian of the UF Library actively participated as ICGIS committee members and because the library had no GIS or RS center of its own, the library became a neutral committee meeting site. Eleven academic departments with GIS and RS components now participate in the certificate program.

In 2000 UF's George A. Smathers Libraries Government Documents Department hired its first faculty GIS Librarian. Establishing a GIS Librarian position was a five-year administrative process. The major driving force for the position was numerous research and student requests for spatial data and processing, mostly related to census data. The first release of FGDL in 1998 and the Map Library's large digital spatial collection also contributed to the need for GIS expertise. Additionally, there was a need on campus for an "in-house" GIS and RS consultant for faculty, staff, and students not associated with a particular research or teaching lab on campus. Besides consulting with faculty, students, and staff, the GIS Librarian teaches courses in the Geomatics Department. Due to the increased demand for GIS consultations, in 2005 a vacant government documents position was converted to a faculty spatial and numeric data librarian, who will actively collect and distribute data.

GIS and RS service and data delivery at UF libraries now includes six public computer workstations, two 11" x 14" scanning stations, four research and consulting workstations, a large format grey-scale scanner, a color laser printer, and a large format plotter. Software includes the Microsoft Office Suite, sixty ArcGIS license seats, and three seats of Leica's ERDAS Imagine software. The GIS Librarian coordinated a shared campus-wide purchase of Leica ERDAS Imagine image processing software. All services and equipment use are provided free to patrons. However, consultations for large projects or involvement in data creation for grants are subject to negotiation. The goal of the GIS Librarian is to provide patron guidance in GIS education in order to enable patrons to produce their own products.

GIS and RS projects at UF libraries have evolved into a collaborative and distributed team of individuals from multiple library departments. The Government Documents GIS Librarian coordinates acquisition, development, and distribution of spatial data in addition to maintaining an Internet Map Server (IMS). The Map and Imagery Library houses paper

and digital collection materials. The Digital Library Center scans, archives, and distributes images that can be used in GIS. Library Systems assists in server maintenance, database development, and Web site programming. Cataloging works to incorporate digital collection records into the library catalog. Lastly, the Florida Center for Library Automation (FCLA) hosts imagery.

The UF Library's mission statement summarizes a commitment to a distributed set of services:

The mission of Smathers Libraries is to support the university community in its pursuit of knowledge, thus contributing to the advancement of the University of Florida to a ranking among the top 10 public universities. Our strategic goals aim at providing excellent information resources and tools to faculty, students, and staff when and where they are needed. We are committed to a service model that imbeds library resources in academic programs, reaches out and collaborates with scholars and others within and beyond the university and adapts quickly to take advantage of technology developments. (University of Florida, 2005)

While the mission of a university library may be to support the academic community in its pursuit of knowledge, namely research and teaching, strategic goals help shape development of services provided and how they are delivered. In this instance goals that deliver "information resources and tools . . . when and where they are needed" and a service model that "imbeds library resources in academic programs, reaches out and collaborates with scholars and others within and beyond the university" are consistent with distributed models of service.

CONCLUSIONS AND TRENDS

Academic GIS and remote sensing teaching and research efforts are growing on large and small campuses across the country. Increasingly, academic libraries regardless of size are developing spatial data services to meet user needs (Kinikin & Hench, 2005). Many library GIS and RS efforts begin as part of another library department, typically government documents or a map library; however, specialized science-oriented libraries are also typical incubators for these efforts. UF libraries' GIS efforts are organized under the Government Documents Department. At FIU, GIS and remote sensing started in Government Documents, but spatial data services have become a unique library department. While university libraries often consider the placement and scope of GIS services, the service and data delivery model are not developed in relation to existing campus enterprise GIS infrastructure.

This article has examined two spatial service and data distribution models, centralized and distributed, that can be applied to any size academic library. By comparison, campus GIS and RS activities and expertise at FIU

began in the library, and as a result FIU libraries developed a GIS-RS Center similar to UF's Urban and Regional Planning GeoPlan Center. In the case of FIU and the centralized model, the cost of maintaining a library center is partially shared by other departments. However, when other college departments already have distributed research centers and teaching labs, such as at UF, they are not motivated to contribute to a library center. Creating a library GIS center in a distributed environment of existing research and teaching labs may force a library to compete against other centers for research grants and budget line item funding. By focusing on the user community and adding coordinate information, or spatial value, to library collections, libraries may be able to avoid competition with other campus centers. Consequently, UF has evolved into a distributed model for GIS service and data delivery that relies on many library departments.

Although FIU and UF libraries embody different service models, GIS efforts of both libraries are centralized in a single library. At UF this raises the administrative question of how to best meet user needs for nine separate satellite library locations, eight different specialized library collections, and over eleven academic units. One current consideration consistent with a distributed network of services is basic GIS and RS education for a select number of reference librarians throughout the libraries. A concern with this approach is the significant amount of time needed to achieve a sufficient level of technological knowledge in hardware, software, and spatial data to meet a user's particular need.

Providing spatial technology services is often seen as prestigious and may encourage some academic libraries to invest in GIS and RS centers; or libraries may feel compelled to keep pace with other university departments or academic institutions. Prior to investing in GIS centers and services, evaluating library enterprise GIS service models in the context of the broader university enterprise will help libraries plan and implement spatial information services that meet a patron's needs.

REFERENCES

- Florida International University (FIU). (2006). *Mission statement*. Retrieved March 23, 2006, from <http://gislab.fiu.edu/portal>.
- Haas, S. C., Kesse, E. J., Aufmuth, J. A., Sullivan, M. V., & Renner, R. D. (2005). From the air: The photographic record of Florida's lands. *OSS: International Digital Library Perspectives*, 21(2), 131-139.
- Haas, S. C., Aufmuth, J. A., Coleman, D., & Uhlinger, E. (2002). MARC and ARC: Geospatially enabling bibliographic records. *Proceedings from the 28th annual IAMSLIC conference, Mazatlan Mexico* (pp. 119-126). Retrieved January 29, 2006, from http://www.iamslsic.org/proceedings_papers/proc02119.pdf.
- Kinikin, J., & Hench, K. (2005). Survey of GIS implementation and use within smaller academic libraries. *Issues in Science & Technology Librarianship*, 42. Retrieved February 6, 2006, from <http://www.istl.org/05-spring/refereed-1.html>.
- Koontz, C. M., & Jue, D. K. (2001). The location of your library building: Why it is important, and how to do it, using GIS (Geographic Information System software). In M. F. Bisbrouck, *Library Buildings in a Changing Environment*, IFLA Publications 94 (pp. 141-153).

- McCormick, B. G. (2003). Developing enterprise GIS for university administration: Organizational and strategic considerations. *New Directions for Institutional Research: Using Geographic Information Systems in Institutional Research*, 120, 63–76.
- Rich, S., Das, A., & Kroot, C. (2001). Spatial data management in an enterprise GIS. *Proceedings of the 2001 ESRI User Conference*. Retrieved January 29, 2006, from <http://gis.esri.com/library/userconf/proc01/professional/papers/pap742/p742.htm>.
- University of Florida. (2005). *UF Library mission statement*. Retrieved May 19, 2006, from <http://www.uflib.ufl.edu/staff-site/budget/ProgramReview05-06.doc>.
- Xia, J. (2005). Locating library items by GIS technology. *Collection Management* 30(1), 65–74.

Joe Aufmuth is a faculty GIS Librarian and the interim Head of the University of Florida's George A. Smathers Map and Imagery Library. He currently serves as one of ALA MAGERT's Cartographic Users Advisory Council (CUAC) representatives and is also a member of the American Society for Photogrammetry and Remote Sensing (ASPRS). He earned an M.S. degree from UF's geomatics program in civil engineering and a B.S. in ecology, ethology, and evolution from the University of Illinois at Urbana-Champaign. He has seventeen years of experience working with GIS and remote sensing in academic research and environmental consulting.