Applying Grospatial Information System in Space Management of Academic Libraries

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Abstract: Gaining information about space and facilities is crucial to the operations of organizations. Libraries, especially academic libraries that are generally constructed on a large scale are also no exception. Designing a powerful space management tool can help libraries increase the efficiency and effectiveness of their daily operations. The goal of libraries is to “develop an efficient and harmonious balance of all the elements that make up a library”. This paper aims at developing geospatial information systems (GIS) technology for libraries. GIS is considered to be better than other systems in incorporating spatial data analysis into visual presentation. It is also cheap and easy to develop. GIS technology is new to library space management. This paper argues that it is a very efficient and effective tool. The simplicity of developing GIS interfaces and spatial databases and the low cost of implementing them, make the technology applicable to nearly every library. This paper offers only a general proposal that aims to call the attention of librarians to this wonderful tool. Actual implementation can only become possible when the advantages of GIS technology have been more widely recognized.

Key words: Academic libraries · Designing · Geospatial information system · Library management · Space management

INTRODUCTION

Space management has become an everyday activity of many libraries. Academic library should be prepared as a suitable location for maintenance and protection of sources. Academic library should be special and have an attractive space for staff and users while providing services and programming [1]. Planning for developing new library's space should be achieved under supervision of planning and designing committee with members including librarian, architect, designer, counselor, official and executive representative of university and user's agent [2].

It is important to consider items as centrality in selecting library location; flexibility to expanding space, security and convenience in designing; and also, efficiency and simplicity of interior design [1]. In the early stages of architectural planning for any university library, stipulations for future development are commonly anticipated by designers. Their expectations, however, generally fail to keep up with dynamic changes in the real world. Accordingly, libraries have to schedule sporadic space re-arrangements in order to accommodate these changes and the decisions about these re-arrangements rest primarily on information derived from daily operations. This makes it necessary to establish a space management system that is able to monitor and record data about how the libraries utilize space and facilities. Such a demand has been particularly popular in recent years when the development of modern technology as a resource and tool for library operations “has been exponential and significant”[3]. There are many situations in daily library operations that inspire consideration of space reorganization. Researchers have systematically explored the causes of space innovations. For example, Fraley and Anderson [3] pinpointed four key conditions under which library space restructuring needs to be programmed:

- Lack of collection growth space;
- Lack of space for people;
- Change in direction or mission of the organization or community served by libraries;
- Introduction of new services.

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Similar studies concentrated lately on balancing spaces of print materials and digital and online information owing to the increase of information technology in modern libraries [4]. Collection growth has been a common topic in library research [5]. The infinite increase of collection numbers is unfortunately restricted by the space ability of libraries. A variety of strategies has been adopted by libraries to control the size of stocks, such as collection pruning, weeding and grafting. Many libraries have invested in compact shelving and microfilm/microfiche substitutes to save physical space. No matter what approach a library has taken, it is essential for libraries to manage the information of space usage for both collection and non-collection sectors. Space reorganization becomes inevitable. Space reorganization is also caused by internal changes involving services for library users or restructuring library staff.

Changes in libraries are not similar. Libraries have not been changed or expanded during time, couldn't remain efficient useful for the present time and it is necessity for them to be changed in conformity with current situation. Some change or replacement should be taken in instruments and equipments as an attempt to modernize organization. In general, changes in library may include: changes in content, structure, goals, instruments and equipments; developmental changes; technical services changes; and changes in programming [6]. But, changes in GIS mostly focus on structure that is called expanding changes. For example, when the collection of library reaches to 100000 volumes, organization of the library should be expanded, some sections should be enlarged and some should be expanded to two or three sections. In this example, library building also should be developed or interior space should be changed.

Some changes in instruments and equipments assure following progress in technology. Additional changes can be done in bookshelf, tables and chairs and in its prominent form, applying computer as a key equipment or using microfilm, microfiche, slide, film and video [7]. Most of the changes involve repurposing space for library users and were particularly common when online services developed since last decade[8]. At an early stage of the development, people witnessed the replacement of catalog cards by the OPAC systems. Then, CD-ROM stations appeared in many libraries. Most recently, the number of computers has been dramatically increased to provide users with access to the internet and networked resources and internet hook-up facilities have been provided for users who want to bring their own laptops into the libraries.

Librarians expect to allocate more space for computers and digital equipment in the future, in contrast to the reduction of library space for print collections [4]. Another changing situation that could potentially trigger library space reorganization is the visible adjustment in the educational mission of many academic libraries. An obvious example is that the libraries have concentrated more on providing users with learning and teaching environment [4]. Instructional activities for bibliographic control or online database searches have constituted an important part of library routines now. The development of information technology makes such efforts possible and easy. The most important technologies affecting libraries, library sciences and its sources are information and communication technologies. These technologies have had some effects on designing library spaces such as changes in physical nature of media in library, as it is evident in adding up electronic books and audiovisual sources which in turn, have led to adding instruments necessary for using these new medias, such as various types of computers, as well as, changing physical structure of the library, for example, establishing computer section, information center and so on [9].

In addition to the situations discussed above, many other elements may also require a reconfiguration of library space, e.g. the introduction of new services and the change of team structures of library staff [10]. The principle is clear that space changes are unavoidable after the construction of a library and during its normal operations. Figure 1 illustrates a space management cycle that many libraries may have already followed in their operations. Please note that the steps of library normal operations and space reorganization would itnerate indefinitely whenever and whatever changes become necessary. Not only is the concept of space management fundamental for the implementation of space reorganization, but it is also important for maintaining the effectiveness and efficiency of everyday library functions. Considerations of routine management may include and must not exclude, library furnishings or infrastructural supports, such as systems for water, temperature, ventilation and electricity. The utilization of similar elements has been out of the reach of many librarians and is somewhat neglected in the rearrangement of physical library facilities. These elements are conventionally regarded as in the hands of maintenance personnel. However, librarians are better off controlling every piece of information pertaining to library operations. Such information is integral to library space management. A space management system becomes paramount for the
The concept of space management automation is relatively new in the library world. The ideal system is one that allows automation and can be managed easily with great precision.

**Space Management System: Practices in Libraries:** Establishment of academic libraries in today’s form conforms with modern law backs to 1855 for Europe and 1850 for America. In studying university library it is necessary to consider libraries of colleges, high schools and so on. The collection of these libraries, called academic library, has been established to help faculty member and students and also to facilitate educational and research processes. Well-known university around the world has big libraries and some times they are evaluated based on qualities of their libraries [9].

In practice, the majority of academic libraries lack an automated space management system in their daily operations. In most cases, if space reorganization is planned, librarians launch investigations to get feedback via interviews and questionnaires from library users, or seek to Discover user behavior via personal observation, in order to analyze the utilization of physical space and facilities [11]. This data, which may be summarized through statistical analysis, serves as the basis for librarians to make decisions about space reconsideration. Alongside the development of information technologies and the recognition of computer power by libraries, some standardized planning tools have recently been introduced to the management of library facilities. Computer-aided design (CAD) has begun to become the choice of the automated space management tool for some libraries. Compared to early computer software in library space planning, CAD is superior for its ability to draw objects. It is also capable of creating three-dimensional views of library objects and structures, therefore dramatically enhancing planning visualization. The Michigan State University (MSU) Main Library has implemented a CAD system in its space management and plans to update and review space changes on a regular basis [12]. Its administrators believe that the implementation will provide a possibility of measuring and calculating the utilization of library facilities, so that the impact of various space allocation decisions on library activity can be assessed. They also advocate a cross-library comparison in order to share valuable information and provide “benchmark measures”. In general, however, only a few university libraries have invested computerized systems in their space and facilities management. The concept of space management automation is relatively new in the library world.

A couple of reasons may cause such negligence, such as financial constraints, lack of computer experts and lack of recognition for the importance of an automated management system. For those libraries that have already established a computerized space management system, the capability of most systems is constrained to the functions of manipulating space visualization. In practice, floor layouts and other library objects are drawn with automated devices and saved into computers. A three-dimensional presentation makes the computerized design and management tool more powerful and flexible in the organization of space objects [13].

**Gis as a Space Management Tool:** According to Burrough [14], GIS is a collection of equipment for collecting, storing, retrieving, changing and demonstrating spatial data of real world to some special purposes. GIS can be used for adding values to spatial data. GIS provide some useful information through organizing and integrating data, analyzing them and producing new data, thereby, facilitate decision making. GIS may be described as a backup system for decision making [7].

GIS have been used to assist in the management of building spaces and facilities in recent years. With powerful capabilities for presenting data in visual formats and analyzing spatial relationships, GIS has gained popularity in both research and practice. Its advantages can be summarized in the following:

- GIS has the ability of performing spatial analysis, a key that facilitates measurement on the utilization of library space and facilities. By treating each individual library object as a unit and collecting the data of library operations associated with the unit, GIS turns spatial analysis into a dynamic magic.
- GIS can treat objects differently by categorizing them and placing each type of objects into individual themes. By overlaying different themes on one another, the interactive spatial analysis becomes an easy task. Thereby, for example, analysis of study rooms can be conjunct with the analysis of pipelines going through ceilings of rooms.
- As part of a GIS package, the spatial database is able to store data related to each object and linked to the visual presentation of the object. Spatial data analysis and visual presentation have become an integrated system.
- GIS can perform infrastructure management at very detailed level, e.g. a study room, a desk, or a chair. The ability to navigate geographically over floor plans and building sketches is easy in a GIS platform.
It is possible to implement the system online so that operating it can be easy and be controlled remotely. This makes maintenance of the system less expensive.

Developing such a system costs almost nothing. Since many academic libraries already have popular GIS software, no further investment on computer hardware and software is required. Any GIS tool that is available can be a good candidate, such as ArcView, ArcInfo, ArcGIS, MapInfo, or IDRISI. The cost of developing the system is relatively low because of the simplicity of the development process. The cost of system maintenance will vary from library to library.

Library Space Management

A GIS Proposal Development: There are two major tasks in the development of a GIS library space management system: drawing the floor plans and building maps and designing the database schemes. In doing the first task, AutoCAD has proven to be a good tool and a regular digitizer linked to the GIS product also works well. Converting an accurate architectural layout of a library building into GIS themes may save a lot of drawing work for developers, while other library objects such as building supports and furnishings will need to be drawn into the files. The MSU Library’s experience shows that “the creation of the CAD drawings was the most complex and time-consuming portion” of such project [12-15]. Nonetheless, as soon as the initial drawing is completed, updates and modifications will be minor and occasional and then the efficiency of the automation tool becomes obvious. AutoCAD drawings directly determine the quality of data visualization and the applicability of simulating space reorganization over the system. Basic requirement for drawing is precision and accuracy of the objects in every dimension. It is evident that objects drawn in proper scale will work perfectly when they are moved onto GIS maps for reorganization simulation. Fancy visual presentations may include the design of encoding colors to reflect various types of objects or various values in databases, the attempt to distinguish minor differences by not only object shape but also color and material (for example, a wooden bookshelf can be differently visualized from a metal one), or the presentation of annotation with meaningful values. Database design is the most challenging part of the development, because a well-designed database will ensure precise yet flexible data analyses in future system maintenance and utilization. According to relational database design principles, objects are entities that will be transferred into database tables. Hence, major database tables may include bookshelves (regular, compact, oversize, etc.), study rooms, study tables, chairs, offices, computers, printers, couches, reference desks, stairs, elevators, maintenance rooms, restrooms, map cabinets, microfiche machines and the like. Activities, which may represent relationships during the stage of conceptual database design, may also be converted to database tables, such as schedules. Architectural and decorative units such as windows, doors, carpets, electric wires, network wire, pipelines (water, heating, etc.), vent tunnels, gates and so on, will also have their own tables. Individual records can be queried by joining relational keys from different tables to return related information, e.g. study-table 1 being related to chair 1, 2, 3, 4, study-room 2, floor 5,... Each database table has a couple of fields that represent features of the object. For example, the table of lecture rooms may contain such fields that tell their size, capacity, equipment, occupancy schedules, use purpose, as well as other information, in addition to relational keys linking each object instance to furnishings inside the room, constructional supports around the room, or the floor location of the room. By associating the graph of each object instance on GIS maps with its feature data in the database, operators of the system are able to work on both visualization and database to perform spatial analysis. Needless to say, designing a good database requires the developers thoroughly to understand library space norms in general and specific situations of an individual library in particular. They must bear in mind future library developments, including its collections and services. It is best to have librarians and GIS specialists sitting together to work out a good development plan [15].

Implementation: Implementation of a GIS library space management system requires the selection of several software components. Any library that has GIS software can eventually adopt the system. ArcView, software patented by the Environment Systems Research Institute (ESRI), is the most popular one and can be found in many libraries that have paid the (reduced) educational license fees. It has powerful functions for graphical presentation and navigation. ArcGIS, an improved version of ArcView, can also be used. ArcView possesses a built-in database that can hold data to interact with visual presentations and engage in data analysis. This database, however, does not handle big chunks of data. A practical solution is to use it to store aggregated information that has been summarized from data in another behind-the-scene
database. Microsoft Access works well to serve as the database and can be costless because of the popularity of Microsoft Office Suite in many library computer systems, if data stored in it are not huge. Otherwise, enterprise-level database management systems such as Oracle or SQL Server should be considered. But generally, Access is big enough to accommodate the data of space and facility management for libraries. Some customization of the GIS and database systems may become necessary in order to produce user-friendly interfaces and enhance the usability of the tool. Visual Basic is a standard computer language incorporated into GIS software and can be used for customizations. Customized interfaces can allow people to input or query data, as well as to present analyzed information in the form of reports, graphical statistics, or other outputs. Web applications are a wonderful alternative to software customization. Online applications have many advantages over some standalone products and are relatively easy to develop and utilize. What is needed for implementing such an online GIS library space management system is to have web server user privileges. Happily all these requirements are basic to the systems that modern libraries have. In terms of computer hardware requirements, current library computer capacities should have no problem with the implementation [15].

Maintenance: As soon as the implementation process is done and necessary testing is completed, the system becomes ready for use. Technical maintenance is only occasional, while normal utilization will be carried out by designated staffs who periodically update the database and/or graphics. Information to be updated may fall into two major categories: the activities of people (users and staff) and the utilization of collections.

The updates can be performed through a combination of different techniques. For example, circulation data may be loaded into the system in order to examine material check-outs; in-library book use may be recorded by reshelvers regularly in order to analyze the behavior of library users pulling out books for reading or reference. An alternative solution for efficiently monitoring the move of library collections is to incorporate an innovative technology – radio frequency identification (RFID) – into the system. RFID is a technology that uses radio waves to uniquely identify items in a library. With the components of a tag, a reader and an antenna, the RFID system is able to trace library items without requiring direct contact or visual scanning. In addition to improving books check-out process, inventory can be taken simply by walking through the shelves and passing a wireless reader wand over the books. Some academic libraries have started using RFID in their collection management to streamline check-in, check-out and inventory tracking, as well as to help minimize theft. The technology can assist in information collection and upon connecting to the GIS database it can automatically make updates for library collection utilization. Yet, the majority of academic libraries still do not have a plan to invest in a RFID system due primarily to its high cost. The GIS management system will have to rely on human efforts to maintain the data on collection movement for some time.

Analysis: Data analysis is one of the ultimate purposes for operating a GIS library space management tool. Analytical units will change based upon different designs for data analysis, but the conduct of data analysis will remain on a case-by-case basis. The means of data presentation by the system can take multiple forms, such as graphical or textual reporting. The presentation of analysis results in graphical form can provide an easy way of understanding and this is simple for GIS tools. Fortunately, most GIS products have also provided dynamic reporting mechanisms to fulfill the task. It is worth spending time to explore such analytical and reporting utilities of the GIS. As soon as the analysis is finished, results can be sent to a report that is customizable, or be presented to graphical interfaces for better visualization. GIS tools are known as an excellent means for spatial analysis and graphical navigation and they have great flexibility for solving problems concerned with library space management. The issue is how to exploit all aspects of their great functionality. Fortunately, only some basic functions will be required in support of library activities [15].

CONCLUSION

GIS technology is new to library space management. This paper argues that it is a very efficient and effective tool. The simplicity of developing GIS interfaces and spatial databases and the low cost of implementing them, make the technology applicable to nearly every library. This paper offers only a general proposal that aims to call the attention of librarians to this wonderful tool. Actual implementation can only become possible when the advantages of GIS technology have been more widely recognized.
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