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Applying GIS in libraries

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Becoming literate in GIS and an active provider of GIS information and services is considered an important long-term strategic investment by many libraries. Whereas the initial impetus for working with GIS was to meet the immediate and pressing demand of providing access to data resources, such as those from population census and other government agencies, GIS has since become an integral part of many library public services plans. GIS services allow these institutions to manage spatial data better on behalf of diverse constituencies and to present opportunities for libraries to rethink current practices, such as cataloguing and access to information during a time of transition, experimentation, and transformation.

1 INTRODUCTION

Recently, libraries of all types – research, public, academic, and special – have become active users and providers of GIS resources (Frank 1994; Lai and Gillies 1991; Smith and Gluck 1996). The interest in GIS has been sparked by a number of factors. The first is the utilisation of new technologies such as GIS in support of education, research, and effective access to information resources. Second, collecting, maintaining, preserving, and providing access to spatial resources is not new to libraries, but the advent of GIS has resulted in libraries exploring new approaches to many, if not all, of these 'traditional' library functions. Third, the rapid expansion and utilisation of networked services, particularly within the academic sector, as communication and educational tools present new opportunities for libraries to address the information needs of a diverse clientele. These changes are occurring at the same time as libraries are in a state of transition, experimentation, and transformation.

To serve a varied clientele, libraries work with a myriad of information technologies and information resources in multiple formats. Indeed, libraries are constantly challenged with the introduction of new technologies, services, and formats (Lyman 1996). They also have to design training programmes that will assist in the effective integration of new programmes and services. Thus the growing array of geospatial information products and services, particularly within the governmental and academic sectors, requires that libraries engage in GIS activities to provide effective access to these digital resources. In the USA, for example, the decision by the US Bureau of the Census to provide key public domain data such as the Topologically Integrated Geographic Encoding and Referencing System (TIGER/Line files) and 1990 decennial Census data in CD-ROM format to libraries participating in a cooperative programme with the government (the Federal Depository Library Program, FDLP) served as the primary motivator for libraries to experiment with and initiate GIS services. The Bureau's adoption of CD-ROM and networked services is illustrative of other government agencies, nationally and internationally. The increasing reliance upon digital resources is not limited to government-produced data. Proprietary GIS-related data from private sector vendors and producers are integral elements in library collections, particularly in academic and special-purpose libraries.

The range of issues identified and addressed by information professionals during a user's inquiry is not unique to GIS and they vary depending upon the user, the inquiry, and the institutional commitment. These issues span the life-cycle of geospatial information from generation or initiation of a data file to preservation and access. Thus librarians and information professionals may address issues relating to: security/privacy, discovery/retrieval, determining the lineage/provenance of the information, archiving/preservation, terms and conditions of use of proprietary information, cataloguing/indexing of data, designing educational programmes, and intellectual property and copyright concerns. Efforts relating to cataloguing of spatial data with a particular focus on metadata are examined later in this chapter as an example of how members of the library community are exploring new approaches to working with spatial resources. Finally, libraries, given their role as a neutral voice in a community, academic enterprise, or related institution, serve in a rather unique capacity as an information dissemination channel or coordinator of programmes. They provide access and avoid duplication of effort regarding digital resources for other agencies or users. Thus in many capacities, working with GIS and spatial resources presents libraries with an opportunity to bridge the traditional functions as these institutions embrace digital and networked technologies.

Within the last years, there has been a great deal of excitement and investment in the building of digital libraries as an extension of the library's current role in the networked environment (see Goodchild and Longley, Chapter 40). These efforts have captured the imaginations of librarians, scholars, educators, geographers, policy makers, and others. One view is of a library without walls where users will have access to resources without regard for physical or geographical location. Recently, in a number of arenas there has been notable progress towards achieving the goal of building a network-based, distributed programme of access to library collections. Such vision and implementation is requiring changes in how libraries select and collect resources, how these collections are managed, and, importantly, how users access these resources. The Alexandria Digital Library project (ADL) is illustrative of digital library projects and of this vision of decentralised access to research collections (see also Goodchild and Longley, Chapter 40). The goal of ADL is to develop a digital library that provides access to large and diverse collections of georeferenced information including maps, remote sensing images, textual materials, and more. ADL is one of six projects sponsored by several US federal agencies. As noted in *Scholarship, research libraries, and global publishing* (Association of Research Libraries 1996):

'In the future, a North American and ultimately international information system will be realised. However, the challenge is managing the transition. Rapid technological advances make it possible to build a seamless web of interconnected, coordinated, and interdependent research collections that are electronically accessible to geographically distributed users. In the new model, research libraries will integrate in-print, local collections with networked regional, national, and international information access and delivery services. In such a networked, distributed system, libraries will play central roles as both providers of research materials and access points for users to those resources, which will be increasingly in electronic form. Realising this vision of the North American digital library will allow research libraries to move to the "just-in-time" model of resource sharing while offering users "just-in-case" desktop access and delivery capabilities. It will also build the foundation for electronic resource sharing on a global basis.'

2 CHALLENGES AND OPPORTUNITIES: LIBRARIES AND GIS SERVICES

2.1 GIS service policies in libraries

As with other institutions, a number of factors determine the level and type of GIS services provided by different types of libraries. The service level will vary depending upon the library type (public, special, academic, research, or state-based), and the institution's mission, clientele, budgetary and staffing considerations. In examining the introduction of GIS services into libraries, two themes are evident. First, no one service model has emerged; rather, each library has formulated strategies to meet local institutional needs. Second, an important distinction arises in defining the 'GIS services' to be provided by libraries. To most

libraries, providing access to GIS or spatially related information constitutes 'GIS services'. Access is defined in the context of traditional library roles – collecting, maintaining, preserving, and archiving spatial information. Increasingly, libraries provide educational services to ensure effective access to these spatial information resources and programmes.

Some libraries go much further than this and offer a suite of GIS services. The National Resource Information System (NRIS) at the Montana State Library, USA, for example, offers a full implementation of GIS services ranging from free online public access, to GIS databases, to standards development and contractual arrangements for sophisticated spatial analyses. NRIS also serves as a clearinghouse for the state of Montana and is an active participant in US discussions relating to the National Spatial Data Initiative (NSDI). More recently, and predominantly within academic institutions, libraries are sites for instructional laboratories. The University of Virginia Library (Alderman Library) and Pennsylvania State University Library, for example, instituted such laboratories that house computers, printers, multiple GIS programs, and digitisers.

The service policy of the North Carolina State University Library is illustrative of the evaluative process that is undertaken to determine a library's investment in GIS services. North Carolina State University Library staff identified three key roles which a library can have in GIS service provision: developing collections of GIS-related materials and spatial information; providing access to spatial information and software tools; and facilitating intellectual access to GIS concepts and applications. Fulfilment of these roles requires librarians to become GIS literate and to assist in the introduction of GIS to library clientele (see *http://www.ncsu.edu/stacks/gis/service.html*).

Developing collections of GIS-related materials and spatial information in support of teaching, research, and public access is an important first step in initiating a GIS service policy and in assisting library staff to become GIS literate. The ever increasing volume of digital data presents new opportunities and challenges to libraries considering the introduction of GIS services. As noted by Abbott and Argentati (1995): 'Selecting spatial data for GIS use is a new aspect of the collection development function, while the management of and efficient access to it is one of the key challenges that librarians face as GIS service providers.'

Providing access to hardware and software tools to permit effective access to GIS resources is a constant challenge to the library and its clientele. The choice of technology and tools will determine, in part, the level of service available and is related to an institution's financial commitment to a GIS over time. An important consideration in the choice of GIS packages is the educational and staff training requirements. There is a blurring of lines with regard to what now constitutes effective access to GIS information, because of the recent introduction of highly sophisticated and powerful GIS desktop packages (Elshaw Thrall and Thrall, Chapter 23). 'Effective' access is defined as useful, meaningful, and timely access to needed resources, yet library staff may not have the time or financial resources to provide *effective* access to constantly changing hardware and software platforms. In addition, the placement of these tools in public service generates fast processing and video display requirements. To avoid inevitable delays, most libraries rely upon high-capacity hard disks, data compression software, and high speed CD-ROM players.

Finally, facilitating intellectual access to GIS concepts and applications is closely linked to the way a library collection is accessed. Such access includes on-demand assistance to an inquiry, designing instructional sessions to meet the needs of the particular community, or (as in the case of the NRIS) specialised database development and analyses. At the Pennsylvania State University, a partnership initiative was created to establish a fully functioning GIS Center in the Maps Room of the University Libraries. The Center is a collaborative effort of the Department of Geography, the Center for Academic Computing, and the Library. The Center for Academic Computing provides some hardware and technical support, the Department of Geography developed a course for students in the Center, and the University Libraries contributed hardware, space, and personnel to coordinate this initiative. Unlike NRIS, the Center is not a production facility. Instead, the Center offers instruction for users both in utilisation of the software and in identifying appropriate data resources. This cooperative model is one emerging at a number of institutions where GIS activities are increasingly collaborative efforts across the enterprise. Such collaboration is evident in other areas; in recent years, there has been a significant increase in campus-based licensing arrangements for

GIS software and data with libraries participating as key players. In the United Kingdom, for example, the Combined Higher Education Software Team (CHEST) GIS procurement in 1990 resulted in provision of GIS software site licences in over 100 academic institutions.

2.2 Staff and training issues

Clearly the level of GIS service offered is the key determinant regarding staff skills and the development of training programmes for both staff and patrons. The significant learning curve associated with GIS has placed new demands on library staff. Staff development and training issues continue to be a key element of the North American Association of Research Libraries GIS Literacy Project. The Project provides a forum for libraries to experiment and engage in GIS activities. The Association of Research Libraries, in cooperation with GIS vendors and users, solicits donations of GIS software and data, organises regular training sessions for Project participants, sponsors an electronic mail list, and works with government agencies on GIS projects and related issues. Support and expertise has been provided by GIS vendors (in particular, the Environmental Systems Research Institute, ESRI), GIS practitioners in the public and private sectors, and foundations. From the outset of the Project, the development of a team of GIS professionals in the research library community willing to lend time and expertise to applications, user training, and education programmes related to GIS, was recognised as key to the successful integration of GIS services in the library arena. Cline and Adler (1995) comment that:

'GIS requires an understanding of computing and the ability to work with visual representation of data, in addition to the knowledge and skills typically found in libraries relating to organisation of data, knowledge of information retrieval systems, reference services, and collection development. To implement GIS as a strategic direction for a library, requires a commitment to developing this special combination of strengths, either in individuals or teams.'

Thus the commitment by library administrators may in fact call for support of several functions, such as collection development, data and metadata acquisition, cataloguing of resources, software and hardware training, access, database management, and more. Strasser (1995) makes a particularly important point regarding GIS services in libraries: 'In libraries where the patrons themselves have no particular expertise in computer mapping, the GIS librarian's skills may have to be proportionally greater.'

The activities of the University of Washington Library demonstrate the commitment of librarians to training and to engaging other agencies and users in new information projects. The University's work also demonstrates how the introduction of GIS services can be an important element in defining, indeed redirecting, how citizens obtain public information. University staff trained librarians at the King County and Seattle Public Libraries in the use and application of GIS. This training now supports the sharing of data files among these libraries, and between the county and city governments. The Project provides a means for public review of proposed community plans in a digital (GIS) format, whereas previously they had only been available in paper format. This has proven to be an extremely cost effective measure for all participants and the sharing of data files has greatly enhanced public access to government information.

3 PARTNERSHIPS

Establishing partnerships within a community, be it an academic institution or a public library serving local community information needs, is another critical component in the successful integration of GIS services in libraries and community projects. Those institutions that have reached beyond the library and have worked in collaborative relationships with GIS users in all settings have been the most effective and successful in becoming GIS literate. For example, James Boxall of Dalhousie University (personal communication) notes the relationship between academic departments and the initiation of GIS activities:

'Those libraries that have longstanding and/or official connections to academic departments dependent upon GIS seem to have had a longer experience with GIS and GIS services in a library context. Those universities such as McGill University, Brock University, University of Victoria, and Queens University, have seen the close association with geography departments and/or GIS programmes benefit the introduction of GIS services in their map libraries.'

Recent experiences at the St Louis Public Library also illustrate the value of partnership with other community-based organisations. The St Louis Public Library collaborated with the Regional Research and Development Services of Southern Illinois University at Edwardsville to create an electronic atlas. Additionally, with the United Way of St Louis and the Regional Commerce and Growth Association, the Library created a series of census data views of particular interest to the community.

There is a strong and important link between establishing partnerships with other GIS users, including government agencies, and library collection development and resource sharing efforts. For libraries in the USA, a great deal of GIS data are generated by government bodies and are in the public domain (by US government estimates US$4 billion). This encourages the sharing of data files via the Internet and other means (see Rhind, Chapter 56, for a review of data pricing issues). Many libraries have gained access to information resources through formal and informal working relationships with agencies and other GIS users. In the USA, libraries receive extensive spatial data via the FDLP, a cooperative programme between 1400 statewide libraries and the government. Federal agencies provide participating libraries with government information (print and electronic) and in return, the libraries provide no-fee access to this government information for a wide array of constituencies.

In Canada, issues relating to crown copyright and cost recovery have, until recently, stymied formation of such cooperative partnerships. Two recent efforts that are changing this state of affairs are the Data Liberation Initiative (DLI) and the GIS in Canadian Libraries Initiative (CLI). The DLI seeks to make Canadian data more readily available to the research and education community. The initiative will build upon existing infrastructure, the Depository Services Programme (DSP), and make selected electronic data files accessible to these communities. Statistical data files are of predominant interest and Statistics Canada has taken a lead in making many of these much-needed resources accessible to members of the Canadian Association of Research Libraries (CARL). The CLI is a cooperative effort between CARL, the Association of Canadian Map Libraries and Archives (ACMLA), and the Canadian Association of Public Data Users (CAPDU). It is focused on government georeferenced data. Canadian libraries seeking to use GIS are seldom able to obtain data from Canadian federal or provincial agencies without incurring substantial costs. Average prices for 1:50 000 digital topographic coverages begin at a few hundred Canadian dollars, and can be much higher. Prices for provincially-based information also vary between provinces. Actual pricing policies are determined at the departmental or division level. The movement towards cost recovery, however, is a general policy trend based upon directives of finance departments at all levels. Because the pricing policy of Geomatics Canada (the federal department responsible) is 'flexible', it is very difficult to attribute any specific price figures. CLI seeks to remedy this situation by joining forces with other organisations in Canada to promote better solutions and increased access to much-needed georeferenced data. With the launching of the DLI (Simon Fraser University's Research Data Library) which has responsibility for providing access to digital cartographic data, there has been a noticeable increase in data orders. Such partnerships are one important means by which many communities and libraries are able to become effective users of GIS.

4 METADATA IN LIBRARIES

4.1 Background

The library community has been very active in cataloguing various forms of information for many years. The most notable efforts in establishing cataloguing conventions are the Anglo-American Cataloguing Rules (AACR) which are prepared jointly by several library associations and national libraries from various countries. The first edition was prepared in 1967 by the American Library Association (ALA), the Library of Congress, the Library Association, and the Canadian Library Association. The second edition was prepared in 1978 by the same groups plus the British Library; and the second revised edition was prepared in 1988 by the Joint Steering Committee for Revision of AACR2, with representatives from all of these associations, plus the Australian Committee on Cataloguing. The process for revising rules is carried out by library associations working in concert with their national library. This tends to be a long-drawn-out procedure that can easily see three

years pass between proposal and acceptance of a rule revision as part of AACR.

The other major rule-making area is that of USMARC (Machine-Readable Cataloguing), a bibliographic record format for automated systems, which is heavily used in one form or another by many different countries, e.g. CANMARC (Canada), UKMARC (UK), and UNIMARC (any country that does not have its own specific MARC). USMARC was first formulated in the late 1960s by the Library of Congress, and has been maintained by that agency ever since. The decision-making body for USMARC is Machine-Readable Bibliographic Information (MARBI). There are many other standards that libraries use, such as Z39.50, the International Standards for Bibliographic Description (ISBD). The focus here is on the various editions of AACR and on MARC.

4.2 Cataloguing spatial data in digital form – activities and status

The library world has done considerable work on cataloguing digital data, as is demonstrated by the inclusion of chapters in the last two versions of the AACR (American Library Association 1978). Work relating specifically to the cataloguing of spatial data in digital form began in the library community in 1990. The Canadian General Standards Board convened the Standards Writing Committee on Geomatics and included a librarian as a member. The final version of this standard – Geomatic Data Sets, Cataloguing Rules – was issued in 1994 by the Ottawa-based Board and the Canadian Library Association.

In the USA, an Information Exchange Forum on Spatial Metadata was sponsored by the US Federal Geographic Data Committee (FGDC) in 1992. The work of this agency was hastened by Executive Order 12906 – 'Coordinating Geographic Data Acquisition and Access: the National Spatial Data Infrastructure' – issued by the President of the USA on 13 April 1992. Among other matters, the Executive Order directed that as of 13 January 1995, every US federal agency would be required to document all new geospatial data it collected or produced, and make this documentation, or metadata, accessible electronically. Spatial-data collection in the USA is heavily dependent upon data issued by Federal agencies. Given the ambitious timetable included in the Executive Order, the Library of Congress's Geography and Map Division – long a leader in the cataloguing of spatial data – began working with the FGDC, the agency tasked to generate a metadata standard. The FGDC issued the 'Content Standards for Digital Geospatial Metadata' in June 1994; later that summer, requests for new fields suggested as 'Content Standards' were presented to MARBI for inclusion in MARC. MARBI gave provisional approval of these fields. A new draft Content Standard was announced in Spring 1997, with comments accepted until July of that year.

4.3 The importance of metadata to libraries and public access to data

Libraries provide access to information in all formats. The existence of standards and rules that are widely accepted and used are essential to effective provision of this service (see Salgé, Chapter 50). In particular, standards and rules are needed to allow shared cataloguing – that is, for libraries to obtain, from some central utility or utilities, existing cataloguing copy, rather than for each library to catalogue each item *de novo*. The *de facto* US central catalogue is OCLC, a non-profit making computer service and research organisation covering over 22 000 libraries in the USA. The pioneering efforts of government agencies in several countries and at several different levels are much appreciated and are closely watched. As a general rule the library community eagerly participates in such projects (American Library Association 1988). It has been helpful to the library community that producers and users of digital spatial data have provided field definitions which have not previously been included in USMARC or in any edition of AACR. The library community is especially interested in seeing how metadata develop in practice, and to ensure that metadata information go beyond what appears in a standard library cataloguing record. For example, all of the fields contained in the FGDC content standard (with the exception of two fields for time) are included in USMARC. It is anticipated that within a few years, these will be included in revisions to AACRR2.

Two recent activities that have assisted in advancing the state of cataloguing spatial data in digital form are a series of workshops co-sponsored by OCLC Inc. and the Alexandria Digital Library Project (see Goodchild and Longley, Chapter 40). OCLC Inc. is a major provider of shared cataloguing in North America, and has extensions overseas. Since early 1995, OCLC's research arm has

been active in setting up metadata workshops. The first one in 1995 resulted in the formulation of the Dublin Core, a set of 13 fields for a minimal description of online digital data. The second, at the University of Warwick, England, resulted in the Warwick framework. The third, at OCLC in Dublin OH in late 1996 focused on metadata for images in digital form. The fourth, at the National Library of Australia in early 1997, resulted in the Canberra qualifiers for elements. Finally, the fifth, at the National Library of Finland, in Helsinki in late 1997, defined further the (by now) 15 descriptive fields.

The Alexandria Digital Library is one of six four-year digital library initiatives, funded by several US agencies. The Alexandria Digital Library has the focus of providing online access to spatial data. Given that an estimated 90 per cent of all spatial data are available only in hard copy, metadata are of overwhelming importance and are a focus of research and implementation.

For current information on metadata in the library community, the following WWW sites provide useful information:

ACMLA: *http://www.sscl.uwo.ca/assoc.acml/acmla.html*
ALA: *http://www.ala.org*
ALA, Map and Geography Round Table: *http://www.sunysb.edu/libmap/magert1.html*
Alexandria Digital Library: *http://alexandria.sdc.ucsb.edu*
Australian Library Association: *http://www.ala.au*
Canadian Library Association: *http://www.cla.org*
International Federation of Library Associations, Section of Geography and Map Libraries: *http://www-map.lib.umn.edu/map_libraries.html*
The Library Association: *http://www.la.org.uk*
Library of Congress: *http://www.loc.gov*
MARC and MARBI information: *http://lcweb.loc.gov/marc/*
OCLC Inc. (Dublin Core): *http://purl.oclc.org/metadata/dublin_core*
Special Libraries Association, Geography and Map Division: *http://www.sla.org/membership/divisions/geo-map.html*
Western Association of Map Libraries: *http://gord.ucsd.edu/mw/waml/waml.html.*

5 SELECTED LIBRARY PROGRAMMES

Each library engaging in GIS activity has developed plans that seek to meet the local needs of an institution and each provides differing levels of service to meet their unique information needs. Many libraries have discovered that the primary issue is no longer of providing access to GIS resources but rather of determining how *significant* investment should be and how it will evolve over time.

The John R Borchert Map Library at the University of Minnesota, a US FDLP regional map depository and the US Geological Survey Earth Science Information Center for Minnesota, has an ambitious amount of GIS activity underway. The Map Library has one of the largest research map collections in the nation, including 275 000 sheet maps, 10 000 atlases and reference books, and over 300 000 aerial photographs of the State of Minnesota. It serves more than 25 000 patrons each year. Using funds from the US Department of Education and the University, the Library established the Automated Cartographic Information Center (ACIC). The ACIC presents one model for academic and map libraries to consider in the provision of access to spatial information. With 11 workstations, a colour scanner, a digitiser, CD-ROM readers, and a colour printer, the ACIC provides a range of technological choices for accessing local, national, and international datasets. The Center is linked electronically to the University of Minnesota's Government Publications Library, the Machine Readable Data Center, and the Geography Department's Digital Cartography Laboratory. One goal of the Center is to explore new products and services that will facilitate access to georeferenced data files. This will ensure that the capabilities of the Center will evolve over time.

Recognising that GIS and related data were a subset of a larger, ever expanding collection of electronic information that the McGill University Libraries were already acquiring, the University Libraries proposed a major teaching initiative for the University. Currently, the Hitschfield Environmental Earth Sciences Library supports academic work in the environmental, atmospheric, oceanic, and geographical sciences. The map collection is one of the largest and most comprehensive in Canada. An assessment of university-wide GIS services was undertaken and a plan for an integrated GIS facility was proposed that built upon GIS efforts within the University. A partnership was formed between the University Libraries, the Geography Department, and other academic departments such as the School of Urban Planning and the Department of

Agricultural Engineering. A geographical information laboratory will be established to train students in methods of analysing spatial and environmental digital geographic databases, in automated cartography, and in methods of accessing digital geographical databases.

The New York State Library, a federal and state repository for public documents, serves the New York state government, legislature, state agencies, and the public. As a depository library, the New York State Library received the TIGER/Line files and other digital data from the US government, but was unable to afford the necessary software to make the data accessible to their clientele. In addition to federal data files, the Library has access to extensive state-based resources, such as wetland spatial data files, which also required GIS software to facilitate access. In response, the Library has instituted a very active GIS program and GIS is now an integral part of the Library's reference service. In response, the Library created a directory containing a basic demographic profile with eight census variables for every census tract in New York State counties. This was in addition to a directory containing the corresponding tract geography for each county. These directories permit clients to work with the information resources prior to requesting assistance from a staff member, thereby saving considerable amounts of valuable staff resources.

6 CONCLUSIONS AND FUTURE PROSPECTS

Becoming literate in GIS and becoming active providers of GIS information and services are considered important long-term strategic investments by many libraries. The initial impetus for working with GIS was to meet the immediate and pressing demand of providing access to data resources, such as those from the Bureau of the Census. GIS has now become an integral part of many library public services programmes. GIS services allow these institutions to manage spatial data better on behalf of diverse constituencies. They also present opportunities for libraries to rethink current approaches to tasks like cataloguing. This can be undertaken in an environment conducive to research, education, and public access.

The spatial library of the future, indeed the library of the future, should have a number of attributes, each of which builds upon current services and extends these services to the digital networked environment. These should include: transparency or the ability to locate information regardless of the user's geographical location through the evolving World Wide Web; the ability to retrieve, access, evaluate, and utilise data and information, including detailed metadata and/or object content; the ability to perform operations on the data which make them meaningful to the user – including the provision of links to other (commercial and non-commercial) providers, and the ability to create user-specific data objects; a legislative regime which permits access to resources in support of research and education; and well trained and committed staff able to build, navigate, and translate the needs of users in this complex networked environment.

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