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RFID implementation in the Vatican Library

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At the very beginning of the Pergamon Project, the Vatican Library aimed at a solution that could integrate the existing OPAC with a new technology such as RFID. The purpose was the creation of a sort of crosswalk between the bibliographic catalogue and the information stored in microchips.

The RFID project was started in 2002 with two initial goals in mind: having an anti-theft system and reducing inventory costs.

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The Pergamon RFID system was developed in collaboration with a Italian software company. It resolved above all an urgent problem, namely that of finding misplaced books. This consequently resolved the problem of the inventory control operations, as well as providing for the return of volumes to their proper shelves.

Everybody knows that since books that are put back in the wrong place are very difficult to find – and this, which can happen even in environments where access is limited only to professional staff, is unfortunately quite frequent in environments where the public is free to consult them. Locating and reordering of the volumes has cost the

Library a lot of time and resources. Manual inventory is a time-consuming and monotonous process but once it is automated it can be done more frequently.

Once materials are tagged, staff can walk up and down the stacks to identify missing or misshelved items with handheld reader devices which work with the library's automation system to generate electronic reports.

It is essential to realize that the books held in a library, like all other cultural assets, are very special objects with specific needs in terms of both cataloguing and conservation, especially if the material is ancient, with a high artistic and cultural value.

It was necessary to adopt a system capable of monitoring the books in real time and of determining their correct position.

The association of data and objects is not easy to achieve and must be approached according to very precise criteria and with a very long-term perspective. Early in the development process we realized that we needed a solution that allowed us to manage bibliographic data and inventory control at the same time. We were looking for a solution that was more than a circulation or an inventory control system, able to retrieve bibliographic information from the existing main catalogue via the Z39.50 protocol.

The choice of how to make the best use of the chip’s memory is determined by the very specific needs of the environment in which it is applied. It fell neither to a simple local memory containing only a pointer to the data contained by the central database, nor to a complex

local memory containing data, additional to that contained in the database. Instead, a third way was chosen that we may define as the "double database", which makes the most of both the great capacity of the tag and of the advantages of the local memory in a continuous and dynamic exchange of information, but without substituting the tag's content for that of the central database. The label is printed on a printer which, in a single operation, prints the bibliographic information about the book on the paper surface and associates these data with the id serial number permanently inserted in the chip.

This double system for recording information on the chip and in the database can be explained by the special nature of the bibliographic context; we could describe it as a complex world of information that changes continuously and in different ways, where it simply would not be enough to transfer data to a chip. The local memory is useful in itself but not sufficient; and if it were not continually updated it would always be "out of date" with regard to the changes made in the main database. The exchange of information in real time takes place through the palm-top reader with RF connectivity and the read/write RFID module that picks up the information from the tags, transmits it to the server through the access points located in each room (connected to the LAN at 100 megabytes) and simultaneously updates the tags.

As a first step I'm going to give a brief description of the Pergamon RFID system's architecture that we implemented in the Vatican Library.

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It is an integrated, multifunctional system for bibliographic holdings management. It applies the MARC21 format, XML syntax and the gateway Z39.50 to connect with the inventory data. Without avoiding double records maintenance, it obtains the tag definition data by directly interconnecting with your library system.
Pergamon RFID is divided into six separate modules.

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The first one is the identification module. It performs the various actions needed to manage the descriptive information of library holdings for the association of data to a tag and the printout of bibliographic information on a smart label.
The first step concerns the uploading of bibliographic records belonging to a collection, directly exported from MARC21 format, from the OPAC via ISO 2709 and converted into the XML format.
For example, for tagging our Reading Rooms' open stack collection of around 400,000 volumes (monographs and periodicals), we followed topographic criteria (e.g. the group of Ancient Latin Literature in the Main Reading Room). The system processes the file and checks the record structure (for monographs, periodicals, and other materials).
The system displays the selected data and automatically detects the number of holdings that will correspond to the number of tags because each volume or physical unit needs a tag inside.
The editing of call numbers or the numbering of different parts is also made possible.

When the staff member has completed his work the file is ready for printing.

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The system can also process multi-part and multi-level descriptions (e.g. miscellanea, archival units, correlations between aggregate items) using a method to associate a set of data to a univocal tag.

In fact, in the context of cultural assets where Pergamon can be adopted, reference information is a composite reality: a sculptural group can be composed of several figures; or a triptych, of several panels. The same thing can happen with books: a single volume can consist of several titles bound together or, conversely, a single work can be divided into several volumes: for example, think of the different issues of a periodical or the volumes of an encyclopaedia. We have to be capable of managing this type of complex information and of discriminating between the different realities or parts of the reality. In the case of several titles bound together which often happens even in modern publications, we certainly could not ‘paper’ the book with more than one label.

The conservation of these works forced us to find a solution: a chip capable of interfacing with any number of bibliographical or descriptive data concerning the object in question.

The system groups the single parts and checks their sub-units. The printing process associates data to the tag in the chip, hidden inside the smart label.

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As concerns the printing process, another important feature is the use of the 4.0.1 Unicode character set: in this way we can print correctly on the label even diacritical marks that correspond to phonetic quantities, in the case of romanization from non-Latin alphabets or other scripts.

Let me now elaborate on the selection of the data stored inside the tag. We decided to include a simple numeric code as pointer: the bibliographic control number that links the catalogue by way of the protocol Z39.50. Pergamon is a Zclient/server based system that allows the management of a bibliographic database, the existing OPAC, so we don't have to maintain two separate databases. The bibliographic information obtained from the OPAC and displayed in Pergamon is updated in real time so no further human resource is involved for the maintenance of the bibliographic data.

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Pergamon is a zclient in RFID mode or in a traditional way where we can input bibliographic data just like author-title search with the association of boolean operators.

The module management enables the procedures for tag detection. It manages handheld remote reading devices for inventories of stacks and reading rooms. It detects missing and misplaced items and counts library holdings. Let us suppose that in a volume there are three works bound together. We can retrieve all three bibliographical records with every detail entered by the cataloguers. Besides the inventory function, there is a powerful system for automatic and manual searches. Queries

can be performed in reading mode by antennas. The system directly queries the external OPAC via Z39.50 protocol because the local control number stored in each tag corresponds to the related attribute of the BIB-I table of the protocol.

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While the identification module resides on PCs only, since it is only needed in the back office for processing and printing labels, the management module is also available as a wireless optional feature. It has been developed for PDAs using Windows CE, to perform inventory and search functions.

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The handheld device is mounted on an antenna to perform inventory search functions and has a number of advantages for identifying and reading tags as well as for inventory in specific environments such as stacks, repositories, bookselves, etc.

The reading of an entire shelf is made possible by the introduction of a hierarchical relationship between a tag that references a shelf as a whole (with the bibliographic control numbers of each volume stored), and the tags in each volume on the shelf.

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Beyond the performing for the detection of objects, another important feature of the system is the association of radio-frequency badges for patrons with tagged documents.

The badges and the tags affixed to the documents are read at the entrance/exit gates by a background system procedure.

The system accepts badges of authorized users and blocks the gates when unauthorized users try to enter. The user's data and the items taken are recorded by the system at each gate. These data provide the base for the Circulation module.

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The modules detect the passage of people and objects through the gates within a specified area. Within a given time frame this system performs a search by name for every patron, using descriptive data and information about the item and the gate used, to track the movements of both the patrons and the items or library holdings.

The modules also detect the passages of the patrons. We can choose any time span and any gate and have the entire history of the movement of a particular book: when it was checked out, its bibliographic description, who read it, how many times it was checked-out and so on.

Pergamon can calculate statistical variations for passages through gates (for example: percentage of requests from patrons of specific items from stacks) and presents results sorted by relevance. Statistcs can be exported into a spreadsheet.

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Access modules manage patron accounts, file personal and contact information, and assign a tag. Query functions are provided for the accounts in order to search for recorded names.

The user badges (valid for both current and previous periods) may be defined using customized parameters (e.g.: staff, public, researcher, student, and so on). They handle the user's personal data with a variety of functions: data input, search, editing of name etc, and scholar reference information.

The access module also manages the gates according to position and typology. The module is set up for the use of the personal electronic badges and its function is closely integrated with circulation and the loan modules.

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The latter manages the check-out/check-in process by using radio frequency to detect the items. It is structured in units that are customized to reflect the library's specific loan and circulation policies (for example: loans outside the Library, consultation within the Library). This module includes: search and reservation of items, check-out/check-in, chronology of loans, management of patron badges, scanning and filing of patron identity cards, fine management, issuing of reminders and of system reports.

The workflow of the circulation begins with reservation of checked-out items, then each library holding is associated to the patron (check-out), check-out time and date are recorded in the memory of tags applied to library holdings. The outbound passage of the item (for loans outside

the Library) is enabled at the control gate. At check-in, the date and time of return are recorded, and fines, if any, for overdue loans are calculated. It maintains a chronology of the circulation of items, recording the names of the patron and the check out/in dates.

Transactions are recorded in the module files and in the tag memory. They can be checked at any time through readings made by way of a radiofrequency antenna.

For authentication, fiscal transactions charge, renewal, and returns is Z39.83 compliant.

For every background routine, system storage, access control, general parameters, the activation and setting of each module are managed by a utilities module in which there are tables of data stored. Here records can be edited or deleted and every action taken is recorded in log files.

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The date of the last reading of each chip is also managed in this module. This is a crucial point in fact, as it's commonly known that the ability of a microchip to maintain the information stored in RFID tags is typically around 10 years but the data retention depends on temperature, humidity and other factors.

Bearing in mind that there could be a 50% default on this guarantee, only five years are really assured, which is very short range. We solved the problem by monitoring the last date reading. In technical terms the procedure is, "write after read, read after write" and in practice this means that each time a chip is read it is also re-written.

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In this way, the chip is given a virtually infinite life. We have also introduced a control procedure that highlights all the chips that have not been used for five years, as can easily happen in a library like ours. Therefore a gap was identified for us that would have been insignificant in the sort of commercial environment where this technology is most frequently applied.

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Now I will say a few words about the choice of tags. The materials used to apply the tags do not damage the documents or items.

The tag comes in a variety of formats and has been specially designed to fully respect conservation principles. Two types have been developed: one for modern material (up to 20th century) and the other for old and rare items.

For the modern material: The tag is applied to neutral-pH adhesive paper labels. The labels come in a continuous roll and may be printed with an ink jet printer. The label is coated with a permanent acrylic-based adhesive for HSE (High Surface Energy)-surfaces and backed by a glassine liner with standard release.

The long experience of our Conservation Workshop has been incorporated into the industrial process for producing labels containing tags. These punched labels, manufactured in roll form and covered by a patent, are printed on special ivory-colored paper (Fedrigoni paper). This paper was carefully chosen for its grain and color so as not to appear out of place on publications that are rather old and precious. A

special, non-chemical, water-soluble glue was used. The result is a label that does no damage to the surface to which it has been applied (it can be removed simply by water), with a view toward preserving the patrimony and respecting the needs of the environment.

At first, it was intended to use the two different types of labels, depending on the age of the book, specifically, whether it was bound before or after the 20th century. As the project went on, it was decided to use the antique type of label on all the books, disregarding the initial distinction because we are sure that modern books are even more delicate than ancient ones.

The Seret company provides the labels (the assemblage of inlay-paper), while the printing/coding of tags is done in the library by means of an ink-jet printer capable of RFID coding.

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The choice of the ink-jet technology was determined by its capacity for greater resistance to ultra-violet rays. It must also be said that stick-on labels are a more reliable identification means for books than those currently in use, so that the tab indicating the call number on the spine of the book could be removed at this point without causing any serious damage.

Both labels have undergone wear and temperature-change tests and have been duly certified by our Conservation Workshop.

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For the time being, after the reopening of the Library to the public (September 2010) after three years of extraordinary building work, the implementation has implied the activation of new facilities. In fact user badges, equipped with RFID chips, provide the public with several further services: from the lockers for patrons to the requests of scholars for the consultation of manuscripts, from the WiFi connection to the access to electronic resources subscribed to by the Library