

***Analysis, Evaluation and Recommendations for
Materials Handling System and RFID
at
Palo Alto City Library***

FINAL REPORT

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Executive Summary

The Office of the City Auditor performed an audit of Palo Alto City Library in 2007 and found that the changing workload called for a change in how the Library handled the workload. The Auditor suggested expediting RFID implementation, assessing the workload associated with circulation and materials handling, and examining new technologies and services.

The City contracted with Lori Bowen Ayre (Consultant) to help assess the Library's workload and to analyze the effect of introducing automated materials handling and RFID technologies at the Library. Consultant was asked to evaluate the capital costs, maintenance costs, staff savings, security ramifications, return on investment (ROI), and other potential benefits of implementing RFID. Consultant was also asked to evaluate automated materials handling (AMH) technologies and to provide a comparison of the costs and benefits of bar code versus RFID based AMH systems.

Like many public libraries, Palo Alto City Library is faced with the problem of too much success. Circulation is high and increasing. Customers expect more from the library in terms of breadth and depth of resources, and they want material available quickly and conveniently. In 2007, over 1.5 million items circulated -- an increase of 50% in the last ten years.

Moving material between the five libraries creates an additional burden for the library. Each year, over 500,000 items are transferred from one library to another primarily as a result of the Library's popular materials request system.

Circulation will increase as a result of joining Link+ system -- a program that expands resource-sharing opportunities for Palo Alto library customers to other library systems throughout the State. Other libraries joining Link+ have had to dedicate an additional 17-20 hours a week of staff time to process Link+ requests.

The Library passed a bond measure in November 2008 to build a new Mitchell Park Library. The new library will be four times the size of the current library and will add 56,000 new print items and 14,000 new A/V items to the Library collection. This will not only increase the workload dramatically at Mitchell Park, but it will increase materials movement throughout the Palo Alto system.

This report recommends that AMH systems be installed at Mitchell Park, Main and Children's Library. The AMH system recommended at each location includes a library sorter with staff induction as well as one or more automated self check-in machines.

Such an AMH system

- eliminates the need to handle any material that needs to be routed to other libraries;
- eliminates the manual scanning of all items ready for shelving and rough sorts them, and;
- allows for automatically printing holds slips.

AMH systems, in combination with RFID, create improvements system-wide for both the staff and the public. Check-in and check-out is easier when bar codes don't have to be located on the outside of the item (RFID readers read the RFID tags through the covers and cases because they are based on radio wave technology, not optical technology). In addition, multiple items can be scanned at once, unlike bar codes which require each bar code to be read one at a time. RFID also makes inventory control (and shelf reading) easier because books don't have to be removed from the shelf to be identified, and this provides the Library with the ability to evaluate their loss rate in order to determine whether security gates are justified.

The recommendation is for the Palo Alto Library to proceed with RFID tagging of their entire collection and then hire an AMH vendor who will work with them to design systems appropriate for their libraries. A sorter with two self check-in units should be installed in the new Mitchell Park Library. Prior to finalizing the building design, additional analysis should be undertaken in cooperation with the AMH vendor to determine sizing and containers most appropriate for each discharge location. For purposes of calculating costs and payback periods, this report assumes Mitchell Park will be configured with an 11-bin sorter with trolleys or totes at each location and two automated self check-in systems (one internal and one external). An AMH system should be installed at Main as part of the remodeling plans that will be undertaken after the new Mitchell Park Library opens. This report assumes a 9-bin sorter is installed at Main with trolleys and totes at each discharge and one automated self check-in system. A small 3-bin sorter with trolleys and one automated check-in system is recommended for Children's Library. Once the RFID system has been in place for some time, an analysis should be performed to determine whether the loss rate justifies the additional price tag of \$210,000 for security gates. The cost of security gates are not included in the overall costs of the system recommended.

The total cost for the AMH and RFID implementation, without security gates, is estimated at \$1,210,285. Maintenance costs are projected at \$65,250 per year.

Many libraries have made the decision to move to automated materials handling and/or RFID, but few have been able to project the payback period for the system prior to installing it. The primary return on investment of automated materials handling is to reduce the number of new staff positions that will need to be created to handle the anticipated circulation increases. Without an automated materials handling system, the new Mitchell Park Library and Main Library will require additional staff positions in order to handle materials handling tasks. The payback period is calculated based on the savings in staff costs projected over the next several years. This report will show that a reasonable payback period for the recommended AMH and RFID system is seven years.

An important benefit of AMH systems is in customer services. Existing staff will be able to spend more time working directly with customers, turnaround for all library material will be reduced from 1-2 days to a few hours, and customers using self check-in systems will have their account cleared immediately.

Introduction

RFID technology caught the attention of some libraries in the late 1990's and early 2000's as a promising technology for improving materials handling tasks for both library workers and customers. Instead of using optical scanners that require line-of-sight, RFID tags could be placed in material and then read via readers through the book covers and CD/DVD cases. Multiple items could be read all at once. Check-out became easier and faster and the prospect for very efficient materials handling systems improved. But, because of the cost and lack of standards (in library applications), many libraries took a wait and see attitude.

Some libraries took the RFID plunge early. Santa Clara City Library was the first library in California to implement RFID starting in 1999. They implemented a sorting system at the same time. Even though this was one of the first generation systems, they continue to report satisfaction with it. They were able to handle higher volumes of circulation without adding staff, and are now making modifications to increase the speed of the sorter in an attempt to keep up as circulation continues to rise.

While most libraries already have automated check-out, many are incorporating automated materials handling (AMH) and self check-in to their existing environment in an attempt to handle the increasing circulation volumes without adding staff. These systems can be implemented with bar codes or with RFID technology. Making the decision to add an AMH system with or without RFID in an existing library depends on the problems the library is seeking to solve, as well as the cost of the transition when equipment replacement, tags and tagging costs are all taken into account.

Most new libraries incorporate RFID-based automated check-out, automated check-in and materials handling into their new building designs because of the benefits of RFID in speeding up processing, making circulation functions easier for staff and customers. With a new library, the bar code-to-RFID transition costs are eliminated, making RFID an easier choice to make. Examples of recent new library building projects that will include or have included AMH systems (almost always RFID-based) are: San Mateo City Library, Contra Costa County Library (three new branches), Minneapolis Central Library, Maricopa County (four new branches), Champaign Public Library, Plymouth Library (Hennepin County), King County Library System (four new branches). In addition, many libraries are adding (or have added) AMH systems and/or RFID to their existing libraries including Los Gatos Public Library, Sunnyvale Public, San Francisco, Santa Clara County, Mountain View, Las Vegas – Clark County, Redding, Berkeley, City of Alameda, Carlsbad, and City of Orange – just to name a few in the region.

Today's library customers expect a lot from their libraries. They expect the library building to be a comfortable, welcoming and safe atmosphere. They expect to do things for themselves (check-in, check-out, request material, find material, use computers, reserve meeting rooms, pay fines, etc). They expect high quality information assistance from librarians to find and evaluate resources. They expect prompt and courteous service. They expect the same instant results and easy to use tools they get elsewhere (including Amazon, NetFlix, Google, and other online service providers).

In order for today's libraries to keep up with the demands of library users, they must change the way they do business. Like any 21st Century business, libraries must take advantage of technologies that make the operation more efficient and free staff from routine back-room tasks so staff can be reallocated to customer-facing tasks. Libraries that have implemented RFID and AMH systems report that they have been able to add new services for customers, decrease turnaround time for library materials, enjoy more meaningful and personalized interactions with customers, and consistently handle more circulation volume – more accurately -- without adding staff.

In July 2007, the Office of the City Auditor performed an audit of Palo Alto City Library and provided the Library with numerous recommendations. The Auditors found that the Library's workload is changing and made three recommendations about how the Library should consider responding to those changes. Two of those recommendations related to RFID.

The following two recommendations are the subject of this report:

AUDITOR'S RECOMMENDATION #6: In order to assess changes in the workload, the Library should annually calculate the workload impact of self-checkout machines, holds, online renewals, inter-branch transfers, new technologies and services such as RFID and LINK+ as well as future technologies and services as they are added.

AUDITOR'S RECOMMENDATION #7: Since check-ins account for most of the Circulation workload, the Library should consider expediting RFID implementation.

The Library contracted with Lori Bowen Ayre (Consultant) to help assess the Library's workload and to analyze the effect of introducing automated materials handling and RFID technologies at the Library. Consultant was asked to evaluate the capital costs, maintenance costs, staff savings, security ramifications, Return on Investment (ROI), and other potential benefits of implementing RFID. Consultant was also asked to evaluate automated materials handling (AMH) technologies and to provide a comparison of the costs and benefits of bar code versus RFID based AMH systems.

Scope of Materials Handling Analysis

Library materials handling encompasses the circulation workflow of library material, including check-in and check-out, shelving materials, pulling items from the shelves, filling customer requests, interlibrary delivery, returning items to their owning library, and handling customer returns.

During the analysis of a materials handling system, the goal is to identify areas where steps can be eliminated or streamlined, to identify changes that can be made to equipment or work areas to reduce grasping of material, and to find ways to reduce the need for staff to rotate, reach, bend, twist, or repeat motions more than a few times each minute as part of their normal workflow.

Reducing the number of times an item is touched throughout the materials handling lifecycle is a primary goal. Reducing the number of touches can be accomplished very

dramatically with automation such as sorting systems, self check-in and self check-out. Sometimes improvements can be found by making smaller changes like recessing scanners into circulation desktops to eliminate the requirement to pick up each item.

RFID technology is often cited as a key component to optimizing the materials handling processes in libraries because it eliminates the need to hold items up to an optical scanner and because multiple items can be checked in and checked out simultaneously.

The following report provides background into materials handling trends in libraries and provides an analysis of materials handling at the Palo Alto City Library.

Current Materials Handling Environment

The Palo Alto City Library system is composed of five community libraries. All the community libraries are very small (less than 10,000 square feet) except Main, which is 26,313 square feet. Despite the small footprint (50,399 square feet for all libraries combined), the Library circulated over 1.5 million items in 2007-2008, a 50% increase since 1997/98.

In 2004-2005, the Library began implementing Libramation's Mark-3 Easy-Check self check-out systems. Installation of these self-checks at all branches was completed in September of 2007. Self check-out has proven very popular with Library customers with over 89% of all first-time checkouts being done at the self check machines.

Introducing self check-out systems created an opportunity for Palo Alto to add new services without adding staff. In 2003, the Library made it possible for customers to place holds on material available on the shelves (status of "In"). The service is enormously popular with customers. The Auditor's report states that 48% of all holds in 2005-2006 were for items that were available and on the shelves¹. The staff time saved manually handling check-outs was re-allocated to pulling requests for customers and placing requested material on the holds shelves.

One of the goals of this study is to identify opportunities for moving staff into positions that are more customer-facing and using available technologies to make better use of human resources while operating more efficiently in the area of circulation and materials handling.

Circulation Functions

Manual systems are used for check-in, processing holds, pulling requests, renewals (although most customers renew their own material online), and account management. Check-out is also a manual system but it is performed by the customer at the self check-out machines.

¹ Auditor's Report, page 21.

Checking in material

Every item that is returned to the library must be scanned to check-in the item. To scan an item involves passing the item's barcode under an optical scanner so that the bar code can be read. Customers may return their items by placing them on the service desk (though this is discouraged) or by dropping them in the internal book drop or external book drop.

Locating the bar code often involves opening the case (for DVDs, CDs and book-on-CD), or opening the book cover. Media and multi-piece items must be checked to make sure all the components have been returned and are in good condition. Any returned item that is missing a piece or is damaged requires additional follow-up by the staff.

During the check-in process, the library system indicates whether the item is to be shelved at the returning library (a "return") or if the item belongs to another branch in which case it must be delivered to the owning library for shelving (a "transit return"). If the item is a return, it is placed on a shelving cart for shelving later. If it is a transit return, it is placed in the appropriate delivery tote. An item often "triggers a hold" (associates the returned item with a customer's hold request) when it is checked in. This means the item will not be reshelved but will instead be made available immediately to the customer who requested it. See Processing Holds for more information about this workflow.

Processing Holds

If an item triggers a hold during check-in, one of two things will happen. If the pickup location for the item is at the same library where the item was returned, a hold slip with the name of the customer who placed the request printed on it will automatically print out. The library staff person wraps the hold slip around the item, and places it on a special book cart for later placing on the holds shelves.

If the pickup location for the item is at another library, the system displays the name of the library to which the item should be sent ("transit hold"). In this case, the library staff person simply drops the item into the appropriate delivery tote.

Delivery services run Monday through Friday so delivery could be next day or it might not occur until the following Monday.

Pulling Requests

Requested items that are on a library shelf must be pulled by library staff. Requested items that need to be pulled off the shelf to fill holds are listed on a system-generated "Request Pull List." The Request Pull List must be printed 1-2 times per day by circulation staff who then go out into the stacks to find the items. When they return to their work area with the items they've found (90-95% are found²), they must scan each item to note the location for pickup and to change the status of the item to "In Transit" or "On Hold." The requested item is then either dropped into the appropriate delivery tote or placed on a cart for later shelving on the hold shelves.

² Items on the Request Pull List that cannot be found kick off another series of activities including being looked up in the catalog again by higher level staff. Ultimately 1-3% of items on the Request Pull List go on "trace" status and may eventually be withdrawn from the catalog.

Customers enjoy the convenience of having their library material pulled for them and appreciate the speed with which they can complete their transaction at pickup. When customers arrive to pick up their material, all their items are grouped together by customer's last name. They can then quickly scan each item at the self check-out machine and go. The entire transaction from the customer's point of view takes just a couple of minutes.

Renewals

Renewals can be handled by library staff at the service desks. In most cases, renewals are handled by the customer online rather than in the library.

Check-out

All of the libraries have self check-out machines, with three to four self check-out machines located at the busiest libraries. There are a total of 12 self check-out machines system-wide. In order to check-out an item, customers must locate the bar code on the material. Barcodes can be found in one of many places: the front of the cover, the inside of the front cover, the inside of the media case, the outside of the front of the media case, or the outside of the back of the media case.

Once the barcode is located, the customer holds it under the optical reader. The percentage of items checked out via the self check-out machines is remarkably high considering that approximately 70% of all library material have the bar code inside the cover. Once the bar code is read, the self-check screen prompts the customer to pick up and scan the next item. When all items have been scanned, a receipt is printed out which shows what has been checked out and when each item is due.

Account Management

The service desk is primarily used for setting up new library accounts, making payment for fines and fees, getting assistance with library resources such as databases and public access computers, and requesting reference assistance.

The Library recently implemented the ability to pay fines and fees online. Service desk personnel accept cash and checks (some libraries accept credit cards) for payment of fines and fees, and update the patron records accordingly.

Materials Handling Functions

Materials handling involves the movement of library material from one place to another whether it is from the book drop bin to the check-in desk or from one library branch to another. In Palo Alto, manual systems are used for all materials handling functions including emptying book drop bins, delivering material between branches, sorting, and shelving.

Emptying book drops

Book drops must be emptied several times a day. This process involves bending over the book drop, reaching in and grasping one or more items at a time and placing each item on one or more book carts. The book carts are taken to a check-in workstation where they are further processed.

Processing Delivery

Each library receives a delivery every Monday through Friday. The delivery is composed of stacks of totes with approximately 30 items in each tote. Depending on the day of the week, a library will receive anywhere from 50 totes (Mondays at Mitchell Park and Main) to two or three (Children's on a weekday). The average number of totes delivered each day to each library is provided in Table 1.

Table 1: Estimated Number of Items Transferred Daily

	Totes Sent Daily	Items Transferred Daily (avg 30 items per tote)
Main	20	600
Mitchell Park	19	570
Downtown	7	210
College Terrace	9	270
Children's	5	150
TOTAL DAILY	60	1800

Processing delivery material is a time-consuming and labor-intensive component of the library's workload. Each item that arrives via delivery tote must be picked up, the bar code located, and the bar code scanned. The system will display whether the item is a return in which case it will be placed on a book cart for shelving, or if it has been delivered to fulfill a hold request. If it is for a hold request, the procedure described above in Processing Holds is followed.

Approximately 30% of the material moved via the delivery service between the libraries is related to filling hold requests. The bulk of the delivery (60%) is of material returned to a non-owning library. A smaller percentage of delivery (10%) is of newly acquired, non-requested material, and items being sent to Technical Services for mending or processing.

Most libraries in cities the size of Palo Alto (and with comparable circulation), have a main library and only one or two branches (if any). The five branch system creates an additional strain on the system because each library can only hold a small collection size making movement among the libraries necessary in order to fulfill customer requests.

Because there is no delivery of items on weekends, the larger libraries can receive up to 50 totes after a busy weekend. In recognition of this, the City Auditor made a recommendation to add delivery on the weekends. See Recommendation #4, from the Auditor's Report (page 18):

RECOMMENDATION #4: The City should fund and the Library should begin weekend inter-branch deliveries to help manage the Circulation workload and prevent backlogs.

The Library prepared a request for the 2008/09 and the 2009/10 budgets to add delivery service on Saturdays, but this was not approved for inclusion in the City Manager's proposed budget that was sent to the City Council.

Preparing Outgoing Delivery

Each library's circulation and/or returns area is equipped with a tote for each of the other four libraries. When circulation staff check-in an item that needs to be returned to the owning library or a returned item triggers a hold for a customer at another library, they simply drop the item into the appropriate delivery tote. No labeling is required on the item.

As each tote is filled, the full totes are stacked on top of one another. By the end of the day, each library has filled somewhere between five and 20 totes that will be transported to the other libraries by the City's courier service Monday through Friday.

Sorting and Shelving

After book drops have been emptied and checked in, and delivery has been processed and checked in, the items must be shelved. During the check-in process, returns get placed on one of several subject specific book carts that are arranged in the area. At Main, circulation staff use seven shelving carts: Adult, Teens, Children/Juvenile, Fiction, Non-Fiction, New, and Mystery. Holds get placed on a Holds book cart. The Holds are placed on the Holds shelf in alphabetical order by the name of the requesting customer. Returns on the subject specific carts must be fine sorted and then all items re-shelved in the proper order (shelving rules vary depending on the section) in the appropriate area. In most cases, returns are checked in and re-shelved within 1-2 days of being returned.

Workspace at Each Library

Each square foot of a library is a highly valuable commodity. Libraries are trying to keep up with the customer demand for more material and more computers while dealing with more and more requests for holds and interlibrary delivery. The age and layout of each library creates different challenges and opportunities for optimizing use of the public and staff areas.

Main

Main's backroom consists of a large open space with enough room for stacking delivery totes, staging book carts and for sorting material. Two internal book drops feed directly into the large bins in backroom. Circulation staff remove material from the book drops and check them in. Delivery totes are arranged in a semi-circle a few steps away from the book carts. There are two more internal book drops that service the library after hours. Those drops are located at the door entrances and materials returned here go into bins that are then removed to the circulation backroom upon opening.

There is a free-standing external book drop which resides in the parking lot, providing a place to return materials from the parking lot and not requiring the customer to walk up to or into the library. This external book drop is emptied twice a day, by moving the bin to the circulation backroom for processing.

Photo 1: Main Library backroom



On average, approximately 20 totes are picked up each day by the courier from the backroom area and 18-20 are dropped off. During peak times and after weekends with no delivery service, Main Library can receive up to 50 totes for processing on Monday or Tuesday.

With the passing of the bond measure, plans are in the works for moving the book drops and the work to the opposite side of the building, but the same basic configuration will be retained. This building project, however, would occur after the completion of the new Mitchell Park Library.

Mitchell Park

Mitchell Park receives most of their returns via a book drop that is accessible both internally (during open hours) and externally 24 hours a day. These returns all go into one large bin located in the circulation workroom, a very small space (approximately 7' x 12') that used to be a hallway. Circulation staff work at two desks used for checking in all returns, processing delivery and holds. Stacks of totes, both empty and full, are scattered around the space. Each book must be picked up and held under the desktop scanner to check it in. The circulation staff processes any triggered holds and places the returns and in-transit items (anything that must go to another library) into the appropriate tote.

Photo 2: Mitchell Park check-in area



There is one free-standing external book drop that is located in the parking lot area. This bin is removed to the circulation workroom twice a day and processed.

By the end of the day, approximately 19 totes have been filled and are staged nearby for the courier to pick up and the courier delivers anywhere from 6-15 totes. As mentioned earlier, during peak times and especially following a weekend, Mitchell Park can receive up to 40 totes.

College Terrace

College Terrace is a very small library (2392 square feet) and very little work space is available for basic circulation functions. The internal book drop is located in the service desk. Circulation staff pull out items from the book drop bin and remove them to a check-in desk to scan and process. This check-in desk is also used to process items received through the delivery.

The external book drop is located in an old unused door that is accessible from the south side of the building. Items returned 24 hours a day into this drop go into a bin inside the library which is emptied and handled the same way as the internal book drop.

On average, approximately nine totes per day are sent out through the delivery service and approximately five totes are received.

Downtown

The service desk at the Downtown Library was recently upgraded to allow check-ins to occur off the public desk. In the circulation workroom, items are returned via an external book drop 24 hours a day. A freestanding internal book drop is located by one of the library entrances and is removed to the circulation workroom for processing twice a day. A second external book drop that is only available after hours goes into a stand-alone bin, which is processed before opening. At a stand-up check-in station in the circulation workroom, items from the book drops are checked in and holds and the delivery are processed.

Delivery totes are placed on shelves under the check-in station and in the surrounding area, allowing for the stacking of totes. Staff sort returned items to these totes as they are checked in. One or two book carts are used to stage material checked in and ready to be shelved.

A storage room is used to stage totes that are ready for pick up by the couriers. On average, this Library sends out approximately seven full totes per day and receives anywhere from one to five totes daily. Empty totes are stacked in the storage room as well.

Technical Services

Technical Services is currently located in a large room of the Downtown Library, but will be relocated to the new Mitchell Park Library. Regardless of its location, Technical Services acts as another “branch” from which items are received, processed and returned. New materials that are ready for distribution to the branches and to fill holds are checked in at a workstation used for processing new materials. These materials are then put on carts and flagged according to their branch designation. A Technical Services staff person then takes these items into the storage closet where they are sorted into their respective totes.

Material that has been mended or reprocessed in Technical Services are scanned (to put them back into circulation) and placed in the appropriate tote in the storage room for delivery.

Children’s Library

This library was recently remodeled and the size of the backroom area, although adequate, was scaled back from the original plans due to cost and space constraints. The space is organized with two stand-up check-in stations and delivery bins located under the check-in desks. Book trucks of returned material take up a large part of the long, narrow space, which also serves as a conduit for traffic from the public area into the staff area. There are two internal book drops that feed directly into the circulation workroom. Items get dropped into book drop bins by customers. Staff remove items from the bin, place them on the counter, check them in, and process any triggered holds.

In addition there is an after hours external book drop that feeds into a bin located next to the front door. This drop is removed to the circulation workroom and processed before opening. Another free-standing external book drop is available 24 hours a day next to a

curb where street parking is available. This is removed, emptied and processed in the circulation workroom at least once a day.

On average, approximately five totes per day are sent out through the delivery service and an average of nine totes are received daily.

Measuring Workload

Circulation vs. Scans

All libraries report circulation statistics but circulation statistics alone don't provide a complete picture of the work involved in each transaction. Scanning a barcode is a motion that circulation staff repeat hundreds of times a day – many more times than the number of circs reported. Libraries want to have high circulation numbers because this demonstrates that the library is popular and well-used. However, at the same time, libraries need to reduce the number of times staff scan items because this is one of the things that creates a heavy workload, adds time to each transaction, and ultimately results in repetitive stress injuries.

Circulation statistics have never adequately captured the number of scans. Before self check-out and without a multi-branch system, one circ (circulation transaction) would involve one scan of the customer barcode, one scan of the barcode on the item to check-out, and another scan to check the item back in. Today, even with the advent of self check-out but in a multi-library environment, a single circulation transaction can require as many as six scans to complete. Below are two sample scenarios that involve customers requesting their items online:

Customer requests an item that is available from the pickup location

1. Library staff pulls the item and scans it to associate the customer's request with the item (trigger the hold)
2. Library staff (or customer) scans the customer barcode and the item barcode to check-out the item
3. Library staff scan the item to check it in after the customer returns it

Customer requests an item from another library's shelf

1. Lending library pulls the item from the shelf and scans to put it into transit
2. Borrowing library scans the item to register receipt from lending library and to trigger the hold
3. Library staff (or customer) scans the customer barcode and the item barcode to check-out the item
4. Library staff scan the item to check it in and put the item into transit to lending library
5. Lending library scans the item upon receipt to check it in as received and to see if it can be shelved

Each time a bar code is scanned, it requires that the bar code be made visible to the scanner. Bar codes located inside the cover of a book or inside the case of a CD or DVD set means that each scan also includes opening the case or cover and holding the item

underneath the scanner. Sometimes handheld scanners are used which involves coordinating both the material and the scanner. The result is that many items are grasped, picked up, held awkwardly and closed as part of each “scan.”

Many libraries have standardized on bar code placement that ensures the bar code is visible (e.g. front, top left corner of item) in order to reduce the handling associated with scanning each bar code. In 2004, the Library standardized on a similar system so that approximately 72,000 of the 242,353 books currently have an easily accessible bar code. However, at least 70% of the collection (based on 2007/8 data), including most of the media (CD, DVD, audio tapes), have bar codes on the inside case or cover.

In order to determine the number of times Palo Alto Library staff scan individual items, we have to look at annual check-outs (and the percentage of them performed at the service desk versus the self-check machines) and delivery items (which have to be scanned when they are sent out and scanned when they are received). Using 2007/8 circulation data and data collected from surveys performed in 2007, we can estimate that library staff scan items over 2.1 millions times per year.

Despite the fact that over 89% (system average) of first-time checkouts are performed by the library customers themselves, and most renewals are completed online by customers, library staff still spend a significant amount of time scanning bar codes in order to check all material in, check delivery material in and out as it moves between branches, pull requests, and process holds.

Table 2: Number of Times Palo Alto Staff Scan Items

LIBRARY	MANUAL CHECK-OUTS AT DESK³	DELIVERY ITEMS SENT PER YEAR⁴	DELIVERY ITEMS RECEIVED PER YEAR⁵	ANNUAL CHECK-INS (EXCLUDING DELIVERY)⁶	ANNUAL # TIMES STAFF SCAN ITEMS EACH YEAR
Main	27,462	154,440	154,440	304,662	641,004
Mitchell Park	41,676	151,320	129,480	510,621	833,097
Downtown	15,450	54,600	40,560	24,429	135,039
College Terrace	24,103	73,320	51,480	42,480	191,383
Children's	17,803	37,440	95,160	149,742	300,145
TOTAL	126,494	471,120	471,120	1,031,934	2,100,668

³ Based on 2007/8 annual circulation data (first time checkouts only)

⁴ Based on 2007 surveys showing the number of totes sent and received via inter-branch transfers

⁵ Based on 2007 surveys showing the number of totes sent and received via inter-branch transfers

⁶ Based on 2007 survey counting average number of check-ins performed at each branch minus the number of items received (and checked in) via delivery.

Auditor's Analysis of Current Workload

The City Auditor's report worked from the assumption that each check-out takes 10 seconds (p. 21). Based on this assumption, the analysts concluded that introducing self check out machines reduced circulation staff workload 1,819 hours (.87 FTE) in 2005-06⁷.

The Auditor's Report does not state how it came to the conclusion that each check-out takes 10 seconds but it is likely that this estimate is high. In a recent study performed by Solano County Library, the time spent on discrete circulation tasks was recorded. In that study, the process of checking-in each item took 5.5 seconds.⁸ The 5.5 seconds does not include the time associated with triggering holds, pulling items off the shelf and putting them into transit for a hold request or checking in the "transit hold" item. "Check-in" in this case only counts the scan that traps the hold for the customer – not the processes related to getting it to the library and/or getting the item onto the holds shelf.

If we assume that each time a staff person scans an item, it takes 5.5 seconds, we can begin to get an idea of the amount of time it really takes to perform complete circulation transactions. As noted earlier, each circulation transaction actually requires 2-5 scans of the item depending on whether the person has placed a hold request for the item (versus pulling it off the shelf for themselves) and where the item came from (the local library or one of the branches). The simple act of scanning a library item as part of today's circulation process takes library workers 3209 hours each year (2,100,668 scans at 5.5 seconds each).

The City Auditor's report defined three types of circulation transactions: check-outs, check-ins, and holds. In fiscal year 2005-2006, they estimated that 70% of all circulation transactions were check-ins, 20% were manual check-outs by staff, and 10% were holds⁹. In this Consultant's report, check-ins performed as they relate to holds fall in the holds workload rather than the check-in workload. As a result, the ratio of these three types of transactions comes out slightly differently. For example, using the data for Main we find that 17% of all transactions handled by Main's staff were manual check-outs by staff, 25% were holds, and 58% were check-ins.

Regardless of which analysis is used, both reports agree that a large percentage of the current workload is associated with check-ins. Therefore, the best way to reduce the workload for library staff is to focus on reducing the number of check-ins required at the desk as well as the check-ins required to process a hold.

ILL and Link+

The Library currently does very few interlibrary loan (ILL) transactions. According to the 2007-2008 ILL Statistics, a total of 240 items were sent and 49 items received. For each ILL item received, the circulation staff at the Main Library create a brief system ILL record (brief title). Most ILL items are picked up from Main's shelves.

⁷ Source: Auditor's Report, page 21.

⁸ The report documenting the results of this study are not yet publicly available.

⁹ Source: Auditor's Report, page 22.

ILL activity is likely to increase as a result of Link+. Link+ is a resource-sharing program implemented with Innovative Interface's INN-Reach product. A two-year pilot project to join Link+ was approved by City Council and began March of 2009. Membership in the consortium would give Library customers' access to the holdings of over 40 area public and academic libraries. Libraries that have joined Link+ report a dramatic increase in interlibrary loans.

For all participating libraries, the work load involved in handling Link+ transactions is significant. For libraries that are not an Innovative Interfaces Millennium library, the work involved in Link+ transactions is particularly high because each transaction requires manually updating both the Link+ system as well as the library's local, non-Innovative, system. Mountain View uses Innovative's Millennium library system. Palo Alto City Library uses the SirsiDynix Horizon library system. The duplicate data entry required for non-Innovative libraries means that Mountain View's workload estimates are approximately half of what the workload is likely to be for Palo Alto. Mountain View City Library reports spending 17-20 hours per week of staff time dedicated to processing Link+ requests.

Mediating Staff Workload

As noted in the Auditor's Report, the effect of introducing self check-out machines and allowing for online renewals reduced staff workload dramatically. However, even with self check-out machines, staff spend a large percentage of their time scanning items to check them in or to change an item's status as part of processing a hold. Circulation staff spend time pulling items off the shelf to fill holds and wrapping labels around items for placement on the holds shelf. They also spend time shelving material, shelf reading (making sure items are shelved in the proper order), pulling expired holds, extracting material out of book drops, handling payment of fines and fees, and helping customers find material.

The question is what tasks can be eliminated or automated using technology currently available. Certain tasks cannot be easily automated, such as wrapping hold labels on material, pulling material from the shelves, and helping customers. However, many of the tasks routinely performed by circulation staff can be eliminated or made easier with either automated materials handling systems, RFID, or both.

Checking in material

While not nearly as popular in the United States as in other countries, automated check-in machines have the potential to reduce the work of check-in as dramatically as the self check-out machines have reduced the work of check-out. Automated check-in machines come in two varieties; one is used by staff and one is used by the public. Automated check-in machines for the public can be located inside the library or outdoors and provide the most benefit to the Library when they feed the material directly into a sorting system.

Automated check-in systems accept items, one at a time, via an induction unit equipped with a belt that conveys the material under a reader and then into a tote, bin or sometimes directly onto a book cart. The reader can be configured to read RFID tags, bar codes, or

both. With a bar code reader, items must be placed on the conveyor in such a way as to enable the reader to see the bar code whereas with RFID tags, no line of sight is required.

Once the reader reads the bar code or RFID tag, the item is checked in and removed from the patron's account. If the check-in process triggers a hold, the item can be routed to a particular location for additional holds processing (i.e. putting a hold label on the item). If the return does not trigger a hold, the item can be routed to a single returns bin or more granularly sorted. Depending on how many sort locations the sorter has, items can even be sorted to a book cart so they are ready for fine sorting and shelving, thus eliminating the step of taking items out of the bin and putting them on a book cart.

Automated check-in systems used by staff (staff induction stations) are generally located in a work room or at a service desk where staff check-in material or process delivery. Staff induction stations in the work room are used to check-in delivery items as well as items dropped in book drops. An induction station located at a service desk can be useful but doesn't generally have the advantage of also functioning as the induction station for delivery items due to space limitations. Processing delivery takes up more room than is generally available at service desks because of all the full totes plus the need to stage empty totes somewhere.

Book drops

Unlike automated check-in machines, book drops do not utilize any kind of conveyor system nor are they attached to sorters. Items are simply dropped into the chute. At regular intervals, circulation staff retrieve the items from the book drop and take them to a desk to check them in.

Libraries with RFID tags can put RFID readers inside the book drops, which make it possible to check-in items as they are deposited. The benefit of RFID-enabled book drops is that the items are immediately taken off the customer account. However, from the staff point of view, there is no savings because each item still needs to be scanned to determine which items triggered a hold, which needs to be sent to a different library, and which are local returns that can be shelved.

Shelving material

As mentioned earlier, automated sorting systems can reduce the time required to shelve material by rough sorting material into bins or even to book carts. For example, Main rough sorts all material that comes in via delivery and via book drop onto seven book carts: Adult Media, Teens, Children's/Juvenile, Fiction, Non Fiction, New, and Mystery. This process can be replicated with an automated sorting system that is either fed via an internal staff induction station or by a self check-in system used by the public, or both.

Shelf reading

Keeping library material properly positioned on each shelf requires constant monitoring by staff. This work is accomplished by shelf reading. A shelf reader checks each item on the shelf to see if it is in the proper order and rearranges material that is misshelved. This ensures that customers (and staff) will be able to find the material on the shelves.

Shelved material with RFID tags can be scanned with a portable RFID tag reader to quickly identify material that is missing or out of order. Some portable readers can also be used to identify missing items. The units, sometimes called inventory wands, are composed of a lightweight wand with an RFID reader on the end. The wand is long enough to read the higher and lower shelves without requiring bending or stretching or step stools. The reader (wand) is connected to a small computer (handheld or portable enough to wear around the waist or push around on a book cart). The portable system stores the inventory information for later uploading to the library system.

Keeping items properly shelved and consistent with the catalog reduces the amount of time staff spend looking for missing or misshelved items to fill holds. Not only are portable readers good for staff, they also provide some benefits to customers who are more likely to find items they are looking for based on the catalog data.

Portable units can be used to locate items that are nowhere near where they are supposed to be. The units can be uploaded with call numbers for all items listed as missing in the catalog. The units can then be used to track down the lost items almost anywhere. All that is required is that the unit must get within 18 inches of the item. When the lost item's tag gets within range, it will alert the staff person that it has been located. Many CDs and DVDs have been recovered this way. The Santa Clara City Library reported that they uncovered certain "private shelving locations" defined by customers who were stashing DVDs they planned to borrow.

Handling payment of fines and fees

The staff involvement in processing fines and fees can be greatly reduced with the introduction of e-commerce (the ability to pay via credit card online). The Library rolled out this capability in 2008.

Benefits, Risks, and Limitations of RFID

One of the recommendations from the Auditor's Report was to expedite implementation of RFID because check-ins account for most of the circulation workload. However, it isn't necessarily true that RFID provides as much relief as automated check-in systems.

RFID readers at the service desk increase the speed that staff can perform transactions because each item does not need to be individually scanned and the items don't generally need to be picked up by staff and opened to locate the barcode; they can just be slid past the reader. RFID-enabled circulation equipment used at service desks can reduce the risk of repetitive stress injuries by reducing the need to grasp items in order to pass the bar code under the scanner. While it is an enormous benefit to enable staff to check-in items without requiring them to pick up and scan each item, it is even better to eliminate the staff check-in process entirely.

With automated check-in systems, library staff do not need to handle the items at all because the customer inducts them, and the system reads the tag or bar code and sorts the item. With a simple three-bin sorter, the material is sorted as follows:

1. holds and delivery items (which need to be rescanned);
2. returns (which can be immediately shelved);
3. everything else.

The idea is to eliminate the need to scan customer returns. Items in the “everything else” bin will need to be scanned in order to determine what action needs to be taken. Items sorted to the holds bin may need to be rescanned to trigger the hold; however, sorters can be equipped to automatically print routing and holds slips at check-in thereby saving even more handling by staff.

So, while RFID tagged materials are certainly easier and quicker to process for staff, it is even more beneficial to eliminate the check-in process from staff workflows entirely (including the process of scanning items returned and the items received via delivery).

RFID Makes Check-in and Check-out Easier for Customers

Automated check-in systems equipped with at least a three-bin sorter provide the greatest workload savings for library staff -- it doesn't matter whether they are based on bar code or RFID. But RFID enabled automated check-ins save time and workload for the customers.

With an RFID enabled self check-in system, customers do not have to worry that the material is oriented properly. They can feed in the items one at a time as soon as there is room on the conveyor.

RFID tagged material improves the self check-out process as well. Not only are the tags more easily read by the self check-out machines but multiple items can be read at once making self check-out even faster for customers.

RFID Provides Better Security Options

One of the recommendations from the Auditor's Report was to expedite implementation of RFID because of the security features inherent in RFID technology. It is true that RFID tags can be used for both identification and for security, making the need for additional security tags unnecessary.

Another benefit of RFID-based security is that it eliminates a step in the check-out workflow (whether check-out is performed at the self check machine or at the service desk). RFID tags are configured with a single security bit that gets switched when an item is checked out. If a customer tries to walk out with an item that hasn't been checked out, the security bit is in the wrong position so the security gates sound the alarm.

While RFID-based security provides many benefits over magnetic systems that have been popular for the last several years, it doesn't have all the kinks worked out just yet. CDs and DVDs, which are at greatest risk for theft, can create conflicts with RFID readers because of the metal components in the media. Vendors have introduced many “solutions” to this problem but it hasn't been resolved completely. Still, for the purposes of deterrence, RFID-based security is more than adequate.

RFID Makes Inventory Cheaper and More Likely

As more and more customers take advantage of their ability to place holds on material, the burden falls on the staff not only to shelve material but to pull material for customers. Palo Alto's library system, like most library systems, generates lists of all the items that need to be pulled from the shelves to fill patron requests. Some items are pulled to fill requests at the local library; other items for requests at one of the other Palo Alto libraries. How long it takes to pull all the items on a library's pull list depends on how well the shelves match what the catalog says.

Few libraries inventory their entire collection regularly. Many haven't inventoried their collection in years. Palo Alto has only inventoried targeted collections when possible losses in those collections were detected. Inventory is one of the tasks that have fallen by the wayside as libraries struggle to keep up with the challenges associated with holds processing, delivery, web-based services, and more and more material. Without regular inventories, it is almost impossible to know how much material is lost due to theft. Many libraries don't know an item has gone missing from the collection until it turns up on their pull list and it's nowhere to be found. This is not an efficient way to maintain an accurate inventory.

One of the benefits of RFID tagging a library's collection relates to the improved opportunities for keeping the library catalog synchronized with the library holdings. However, for the library to benefit from this capability, it needs to implement an inventory schedule that will ensure that the holdings and catalog are kept in sync. Many libraries that have implemented RFID have not taken advantage of this capability despite the ease with which a complete inventory can be conducted with a portable RFID-enabled inventory device. Some vendors estimate that inventories can be as fast as 500 items per minute. For a library collection the size of Main (approximately 122,000 items), the inventory could be done by one person in a day or two. The smaller libraries like College Terrace (collection size approximately 17,000) could be inventoried in a few hours.

An additional benefit of frequent inventories is that the Library can analyze the loss rate of materials due to thefts. Most libraries estimate their loss rate but don't really have hard data to document what has gone missing and how much it is worth. Better security is one of the benefits of an RFID system over a bar code system because the tag performs the functions of both the bar code (identification) and the security tag (security). However, security comes at a pretty high cost especially at Palo Alto because of the large number of security gates that would be required. Before adding security gates at each library, it may be worth analyzing each library's loss rate to see where security gates are warranted.

RFID Standards Close But Still in Development

RFID is a mature technology that has only recently been incorporated into the supply chain, medical¹⁰, and library markets (among others). The first California library to

¹⁰ One of the dangers of new technologies is unintended consequences. For example, some RFID devices have shown to interfere with critical care equipment in hospitals. Studies are currently being done that will inform best practices for both hospital and library use.

implement RFID was Santa Clara City Library in 2000. By 2006, 27 California libraries indicated that they were using RFID systems¹¹.

RFID technology for libraries suffers from a lack of standards. Early adopters bought tags that aren't necessarily usable with today's RFID systems. RFID readers, security systems and materials handling systems are often purchased from a single vendor in order to ensure that all the components and tags work together. Tags that any library buys today will not necessarily work with all the circulation or security components a library might like to use in the future. One of the big standards hurdles is a data model standard. The data model specifies what information can be stored on a tag and where it will be located on the tag. This is an important first step toward interoperability.

In December of 2006, the NISO RFID Working Group published a Best Practices document¹² that included a data model. Note that this is not a *standard* but a *recommendation*. The goals of the NISO RFID Working Group are:

1. To review existing RFID standards, assess the applicability of this technology in U.S. libraries and across the book publishing supply chain, and promote the use of RFID where appropriate.
2. To examine and assess privacy concerns associated with the adoption of RFID technologies in libraries
3. To investigate the way RFID may be used for the circulation or sale of books and other media in the United States and make recommendations.
4. To focus on security and data models for RFID tags, along with issues of interoperability and privacy.
5. To create a set of recommendations for libraries with regard to a tag data model and other issues.

Ultimately, the NISO RFID Working Group seeks a future where library RFID technology is truly interoperable (nationally as well as internationally) and personal privacy is protected. Ideally, tags will support advanced functionality and security, and can be used the entire lifecycle of the library material. The availability of Best Practices Guidelines and a data model recommendation are an important start to achieving interoperability but isn't a standard that binds vendors. Even if vendors choose to meet the current data model guidelines, there are barriers to interoperability including issues related to encrypting and encoding of the data, proprietary security functions, and firmware that is system dependent.¹³

Libraries considering implementing RFID should follow the guidelines provided by the NISO RFID Working Group which include selecting a vendor that is compliant with the

¹¹ Engel, Elena (2006, July). RFID Implementations in California Libraries: Costs and Benefits. Available from <http://www.cla-net.org/included/docs/IT3.pdf>

¹² NISO RFID Working Group. (2007, December). RFID in U.S. Libraries: A Recommended Practice of the National Information Standards Organization (NISO RP-6-2008). Available from http://www.niso.org/apps/group_public/download.php/116/RP-6-2008.pdf

¹³ Ibid

current NISO data model recommendation and a vendor with a published migration path for ensuring ongoing compatibility with new standards. Compliance with the guidelines provides the best protection that the library's choice of vendor and product will be interoperable with existing and future technology, and will preserve the library's investment.

RFID is Expensive

Ironically, the cost of RFID tags is not the primary expense associated with implementing RFID at Palo Alto City Library. The biggest expense is related to the equipment that would need to be upgraded or replaced in order to take full advantage of RFID technology.

Tag Costs

Individual RFID tags come in two basic types: one for CDs and DVDs and another tag that works for most everything else. The cost of NISO compliant media tags¹⁴ can be as low as \$0.85, and compliant tags for everything else are available for \$0.39. Even using higher per tag costs (\$1.25 and \$0.45) for the Library, the cost of tags for the entire collection comes to approximately \$150,000. By comparison, if the Library decided to move forward with materials handling automation such as sorting and automated self check-in, the cost of new bar codes (to apply to all material that doesn't now have a bar code on the outside) would cost well under \$10,000 (see Table 3 Comparison of RFID v Bar Code Costs.)

The cost of tags has slowly but consistently gone down over the last 7-10 years. It is likely that this trend will continue for the next several years especially as more and more libraries make the transition to RFID and the tag-makers benefit from efficiencies associated with the higher volume. That said, the cost of library tags will never approach the \$.05 per tag that people often associate with supply chain tags. The tags used in library applications are much more expensive because they need to survive as long as the library material survives and because library applications are much more complicated than the relatively simple inventory control requirements of supply chain RFID applications.

Tagging Costs

Applying RFID tags to every item in the collection takes time that must be taken into account when evaluating the relative benefits of RFID. However, in the case of the Palo Alto Library, the labor cost of applying RFID tags to the entire collection compared to the cost of re-barcoding 70% of the collection is not dramatically different. Assuming a three worker team, each of whom is being paid \$20/hour, to tag or re-barcode at a rate of 300 (RFID) to 400 (bar code) items per hour, the cost of RFID tagging comes to \$56,365 whereas the cost of re-barcoding comes to \$30,485 (see Table 3 Comparison of RFID v Bar Code Costs.)

¹⁴ The per tag costs provided to the Library in the RMG Consultant 2006 report entitled Feasibility of RFID/AMH Implementation for Palo Alto City Library were higher than quotes gathered by Consultant from recent RFP responses from vendors. 3M recently quoted NISO compliant CD/DVD tags at \$.85 (versus the \$1.25 quoted in the RMG Report) and \$.57 for their Enhanced tag (versus \$.65 in the RMG Report.) Envisionware offers NISO compliant tags for as low as \$.39 each.

Equipment Costs

The biggest cost associated with implementing RFID is the cost of purchasing or upgrading equipment to work with the RFID tags. For example, replacing bar code readers in circulation areas throughout the Library at a cost of \$3,500 each would cost over \$87,500 (assuming 25 are needed). According to the Libramation representative, it would cost \$5265 to convert each of the self-check machines to RFID (12 units in place now).

Another significant expense is the cost of the new RFID security gates (\$15,000 each) that would be needed at each library exit. If the Library chose to install security gates at all 14 Library exits, the cost would be \$210,000.

Portable inventory units vary from vendor to vendor but run between \$5000 and \$7500 each. Each conversion station (for converting the collection to RFID) costs at least \$3500 (although these can sometimes be rented more cheaply).

In summary, the Library would need to spend approximately \$200,000 (excluding the security gates), and maybe as much as \$408,000 just on the equipment necessary to take advantage of the RFID tagged collection.

In contrast, the only additional equipment needed for re-barcoding items that have internally located barcodes requires a barcode duplicator and tape to cover the new bar codes. The only additional equipment cost is for one additional duplicator, the bar codes, and tape (\$4,000).

In an RFID system, bar codes continue to be used in combination with the RFID tags. The bar codes serve as a backup means of identifying material if the RFID tags cannot be read and the barcode is also the identification used when an item moves outside of the local system. Therefore, the ongoing processing costs of new material increases by the amount of the RFID tag.

Table 3: Comparison of Bar Code versus RFID Tag Costs

TAGS	<i>Total</i>	<i>Print</i>	<i>Periodicals</i>	<i>Audio Cassettes</i>	<i>Tag / Barcode Cost</i>	<i>CD</i>	<i>DVD</i>	<i>Cost of CD/DVD Tag / Barcode</i>	RFID TOTALS	Barcode Totals
RFID Tags	281,823	242,353	8,500	2,320	\$ 0.45	11,300	17,350	\$1.25	\$ 149,740	
New barcodes Needed	203,235	169,647	8,500	2,088	\$0.025	5,650	17,350	\$0.12		\$ 7,266
Barcodes Outside/OK		72,706		232		5,650				
TAGGING	<i>Items Tagged per Hour per Team</i>		<i>Team Size</i>	<i>Team Hours Needed</i>		<i>People Hours Needed</i>		<i>Hourly Wage of Taggers</i>		
RFID Tagging	300		3	939		2818		\$20	\$ 56,365	
Barcoding	400		3	508		1524		\$20		\$30,485
EQUIPMENT	<i>Readers for Circ Areas (25 @ \$,3,500)</i>	<i>Cost to RFID enable Self Check Out Units (12 @ \$5265)</i>	<i>Security Gates (14 @ \$15,000)</i>	<i>Cost of Inventory Wands (5 at \$7500)</i>		<i>Cost of Conversion Stations (2 RFID @ \$3500; 1 bar code duplicator at \$2000 plus tape)</i>				
Bar Code Supplies							\$4,000			\$4,000
RFID Equipment Totals	\$87,500	\$63,180	\$210,000	\$37,500		\$7,000			\$ 405,180	0
TOTAL COST OF PREPPING LIBRARY FOR AMH (INCLUDING SECURITY GATES)									\$ 611,285	\$41,751
TOTAL COST OF PREPPING LIBRARY FOR AMH (WITHOUT SECURITY GATES)									\$ 401,285	

Ongoing Costs

In addition to the start-up costs associated with RFID, there will be increased costs associated with processing all new material. For example, with the expansion of the Mitchell Park Library, the Library expects to add 56,000 additional print items to the collection and 14,000 A/V items. The cost of tagging these items comes to an additional \$42,700 (over simply barcoding them).

All new material purchased will need to be barcoded and RFID tagged. The Library estimates adding 25,000 new print items to the collection each year and 8,000 A/V items. The additional cost of RFID tagging new acquisitions, per year, comes to \$21,250.

Automated Materials Handling Options

The primary benefit of automated materials handling is that several steps in the check-in and sorting process can be taken out of staff hands. By installing automated self check-in systems, customers can check-in their own material almost as easily as *returning* it. In most libraries, customers appreciate having self check-in because they can be assured that no late fees have been assessed and they won't bump into item limits once they are in the library. Having the option to print a receipt for their check-ins is also a feature enjoyed by customers.

RFID enabled self check-in systems are extremely easy for customers to use. There are no worries about placing the items on the conveyor belts one way or another so the whole return process is faster. RFID tagged materials also encounter fewer read errors because of damage to the items that can cause the bar code to be obscured (e.g. spills, torn bar codes.)

The cost of RFID-enabled AMH equipment is virtually the same for barcode based systems. In fact, many systems are equipped to read both. There are three basic components of an AMH system: self check-in machines, staff induction stations, and sorters.¹⁵ The components must be individually selected and sized according to the needs of each library.

In order to select the appropriate components for a library, it is important to understand how the different components benefit the library and customer, what steps in the process get automated (and which remain manual), and what conditions must be met to optimize the equipment. There are several different pieces of AMH equipment and potential features that come into play when finding the right fit for any library: self check-in machines, staff induction stations, sorters (library sorters and central sorters), tote manifesting and automated holds printing.

Self check-in machines

A self check-in machine is a machine that allows the customer to return material to the library and have the material immediately checked in and taken off the customer's account. The machines can be configured to print receipts automatically, not at all, or at the customer's request.

Self check-in machines can be installed inside the Library or on exterior walls (like a typical book drop). The external units can be configured to require a valid library card before the chute will open, or they can be configured to accept material without requiring a library card at all. A good self check-in machine will not allow non-library material to be accepted into the library. If a bar code or RFID tag is not detected, the material is returned to the customer before it gets all the way into the library.

Self check-in machines communicate directly with the library system to do the check-in process. The library system tells the sorter what it needs to know about the item in order to sort it properly. If no sorter is connected to the check-in system, the item just gets dropped into a bin and must be scanned by a staff person to determine its status. In this case, the only benefit of an automated check-in system is to the customer because the item immediately comes off their account.

An automated check-in system can accept items at the rate of approximately 1000 items per hour. Accounting for the time each customer takes to read the instructions, scan the barcode, feed each item onto the conveyer one at a time, and get a receipt, the actual speed is closer to 650 items per hour, according to FKI Logistex representatives.

¹⁵ The costs of AMH equipment presented in this proposal are based on FKI Logistex pricing from May, 2008 and represent costs of equipment including installation for a straight-forward installation.

Staff induction station

Staff induction stations work just like self check-in systems but they are used by staff instead of customers. They can accept items as fast as 1200 items per hour (20 items per minute) depending on the speed of the library system. It is almost twice as fast to feed items into a sorter as it is to scan an item by hand (20 items per minute with induction station versus 11 items per minute to manually scan).

Just like the self check-in machines, the staff induction station communicates with the library system to check-in the item and/or read the status of the item to determine what to do with it.

Staff induction can be used at a service desk, in a workroom, or both. They are always used in combination with a sorter.

With a staff induction station, the person receiving delivery feeds the items into the sorter where the bar code (or RFID tag) is read. The system checks in the item and sorts it to the proper bin or tote. This not only eliminates one manual scan, it also handles the rough sort and holds slip printing – in half the time it would take to manually scan the item and place it on a book cart or table in preparation for additional sorting and processing. In addition, transferring material from a sorting cart used at a check-in station to a shelving cart invariably involves getting up from the workstation and taking the full cart of checked in material to a different location and transferring the material to a number of different shelving carts. This is significantly more time consuming than removing material from a bin that is already rough sorted and simply needs to be loaded onto a shelving cart.

Table 4: Time spent (in seconds) on steps involved in checking in delivery

	Induct/Scan	Rough Sort	Transfer to Shelving Cart	TOTAL TIME	Time Savings with Automated
Automated	3	0	1	4	5.5
Manual	5.5	1	3	9.5	

Therefore, while it takes time to place the items on the sorter, the net savings in time is comparable to completely eliminating the scanning step for processing delivery (5.5 seconds).

Sorters

Sorters are composed of two primary components including the conveyor that moves material to the appropriate discharge location which is equipped with a book cart, bin, trolley, tote, or media tote.¹⁶ The book carts used in sorters hold, on average, 40 items, and are specialized book carts designed to fit into the sorter. Delivery bins or trolleys are generally higher capacity receptacles that can hold 200 items or more. Totes are plastic containers often used for interlibrary delivery and can hold, on average, 40 items. It may

¹⁶ See Appendix 1 for additional information about each of the types of discharges available.

be possible to use the a library's existing totes in a sorter (depending on the vendor and the tote currently in use). Media bins are smaller capacity receptacles designed to hold only DVDs and CDs.

The other piece of the sorter is the scanner and communication device that reads the item's bar code (or RFID tag) and then communicates with the library system to check-in returns, trigger holds, and route the item. Depending on what the library system reports back to the sorter about the item's status, the item will be sorted to the appropriate discharge location for shelving and/or further processing.

While the equipment is similar for both a library sorter and a central sorter, the configuration and function of the two is different. A central sorter is designed for the purpose of sorting interlibrary deliveries. In order to perform this function, all delivery totes must be taken to a central location where the items are removed from the totes, run through the sorter and sorted into totes designated for each library branch.

Library sorters, or return-to-shelf sorters are designed to rough sort material in order to optimize the reshelving process. This means that several of the discharges will be equipped with smaller trolleys or book carts that can be used for quickly returning items to the library shelves. A few discharges will also be equipped with totes to handle the library's outgoing interlibrary deliveries.

Library Sorters

The basic configuration of a library sorter in the Palo Alto Library system would include the following discharges:

- 1) Local Holds (which require additional processing)
- 2) Delivery for Library One items (including holds)
- 3) Delivery for Library Two items (including holds)
- 4) Delivery for Library Three items (including holds)
- 5) Delivery for Library Four items (including holds)
- 6) Subject or Format Specific Returns, e.g. Fiction (ready to fine sort and shelf)
- 7) Subject or Format Specific Returns, e.g. Media (ready to fine sort and shelf)
- 8) Subject or Format Returns, e.g. Adult (ready to fine sort and shelf)
- 9) Exceptions (anything that doesn't meet the above criteria or can't be sorted at the time that it comes through the system)

Local Holds are items being received by the library to fill holds for their local customers. These items sort to a bin equipped with a printer that automatically prints out hold slips for each item deposited into the bin (more on this below).

Delivery items are items that need to be sent to another library because the return of the item triggered a hold elsewhere, or because the item was returned to the non-owning library. Because there are five libraries in the system, a library sorter would need to be configured with four delivery discharges – one for each library – in addition to whatever sort locations were needed for the local library.

In addition, one discharge must be dedicated to everything else (aka *Exceptions*). Exceptions are items with bar codes or tags that can't be looked up in the system (e.g. items from out of system libraries) or material that couldn't be sorted to a bin because the library worker was in the middle of swapping out a full bin for an empty bin.

The remaining discharges, as many as can be fit into the available space, are used for sorting library returns. Returns can be sorted by anything that is part of the item record (e.g. status, format, location). The ideal scenario is that each return discharge is equipped with a book cart so that material can be fine sorted and re-shelved from the cart. However, each cart only holds approximately 40 items so if the number of items likely to be sorted to that book cart exceeds the ability of the library to get the material shelved, it is better to use a bin or trolley instead of a book cart. Bins can hold over 200 items so do not need to be so closely monitored.

Items in bins have to be transferred to book carts and fine sorted before shelving. Sorting to bins is less efficient but it eliminates the stress of keeping up with the incoming material. Deciding how to breakdown each sort location and selecting the appropriate receptacle requires a daily and perhaps even hourly analysis of each library's material workflow. This should be done in partnership with the sorting vendor.

Automatic Hold Slip Printing

Automatic holds printing can be implemented in a number of ways. It is most useful in a situation where the library has a sorter where one sort location can be dedicated to holds. The printer can be placed near the bin (or tote or book cart) containing the items designated as holds so that staff can match the printout with the items as they are sorted. It is also possible to automatically print out holds slips as items are checked in via the tote manifest system. However, if too many holds slips are being printed at a time, the process of matching the items to the appropriate holds slip can get unwieldy and results in no time savings.

Tote Check-in (a.k.a tote manifesting)

Tote manifesting is when the sorter keeps track of each item that gets placed in a delivery tote and associates all the data needed with one bar code number. When the tote is delivered to the receiving library, instead of scanning each item separately, the staff person scans the tote's bar code to kick off a batch load of the data into the library system. Tote check-in eliminates the need to check-in individual items received through delivery and does not require automation at the receiving library (except software and a bar code or RFID reader).

Central Sorters

Central sorters are sorters that are used to sort material moving between libraries and are equipped with totes at each discharge location. They are not used to do rough sorting (e.g. Media, Adult, Fiction) to trolleys or book carts. Often, central sorters are located at a warehouse space separate from a library and all material is sorted to totes. However, Palo Alto has no such separate space so a sorter performing central sorting functions would also need to provide some local sorting for the library housing it.

All items returned to the central sorting location would be scanned by the sorter and if they are local returns, they would be checked-in and sorted to the local library's return bin. Ideally, any items returned to the local library requiring additional processing would be sorted to a separate location for additional processing.

All of the rest of the discharges would be equipped with totes that separated each library's material into the same two categories: returns that are ready to fine sort and shelve, and items that require additional processing.

The minimal configuration of a central sorter suitable for Palo Alto would include the following sort destinations:

- 1) Holds for Library One (anything requiring additional processing)
- 2) Returns for Library One (anything ready to put back on the shelves)
- 3) Holds for Library Two
- 4) Returns for Library Two
- 5) Holds for Library Three
- 6) Returns for Library Three
- 7) Holds for Library Four
- 8) Returns for Library Four
- 9) Holds for Library Five
- 10) Returns for Library Five
- 11) Exceptions (anything that doesn't meet the above criteria or can't be sorted at the time that it comes through the system)

Central sorters are most useful when used with tote manifesting (see explanation above) but can also be beneficial without tote manifesting if all the items in the return totes can be shelved immediately and don't require staff to scan each one. To enable this feature, the library system must be able to change the status of In Transit items to Being Shelved after some number of hours of being sorted by the central sorter.

Items in the Holds delivery tote would need to be rescanned by library staff in order to trigger the hold and to have the holds slip automatically printed.

Central Sort Not a Good Fit for Palo Alto

The reason that the central sort option does not suit Palo Alto is that it would lengthen turnaround time of interlibrary deliveries. If each day's delivery totes were taken to a central sort location and then sorted, they would not be delivered until the next delivery day which is Monday through Friday.

It would be possible to continue providing same day service if the delivery service ran twice a day; however, the delivery service is currently only provided by the City once per weekday.

Should the Library decide to offer expanded delivery services such as Home Delivery, a central sorter configuration should be reconsidered because then the central sorting location could also serve as a shipping center for the Library. Since no such services are

currently planned, the central sorter option does not provide as much benefit to the Library as automated check-in with library sorters does.

AMH and RFID Recommendation

The circulation and materials handling workload for all Palo Alto libraries is likely to continue rising. The new Mitchell Park library will not only create more materials handling volume at Mitchell Park, it will increase circulation and interlibrary transfers system-wide. In addition, joining the Link+ system will dramatically increase ILL requests and the requisite interlibrary transfers.

AMH systems at the busiest Palo Alto libraries will significantly reduce the repetitive motions associated with circulation and materials handling as well as improve services for customers who increasingly expect faster turnaround times and instant results. These libraries will benefit dramatically from AMH whether it is implemented with RFID or bar codes. However, a system based on RFID offers some significant advantages for the entire system, not just the libraries with an AMH system.

All circulation staff benefit from using RFID readers instead of bar code scanners because several tags can be read at once, and book covers and cases don't need to be opened to read the tags. Instead, they will often be able to slide stacks of material across the desk to check them in or to change the status.¹⁷ The ability to perform frequent inventories will increase the likelihood that both staff and customers find items they are looking for on the shelves because the library catalog will be more accurate.

Customers will appreciate how much faster and easier the self check-out equipment is to use and will appreciate that they can check-out stacks of several items all at once.

AMH systems at Main, new Mitchell Park and Children's implemented with RFID without Security Gates

The best choice for improving materials handling as well as the customer experience is to install the recommended AMH systems at Main, the new Mitchell Park Library and Children's Library in combination with implementing RFID for materials across all libraries.

One of the benefits of RFID is that it provides opportunities for frequent inventory of the Library collection. More frequent inventories make it possible to determine what the actual loss rate of material is due to theft. Given the high cost of security gates (\$15,000 each) and the large number of them required to secure all the library exits throughout the system (14), it would be worthwhile to hold off on installing any security gates until the

¹⁷ It is possible to reduce some of the grasping required during check-ins at the service desk using bar codes. 3M sells a product called the 3M 943 that can be recessed into a circulation desk so that material can be passed over the optical reader without being lifted. These units retail for \$10,760 and they can read bar codes as well as sensitize and de-sensitize security strips. It is fairly straightforward to recess these units into any circulation desk.

Library determined that the loss rate justified the high cost. The cost of installing security gates is approximately \$210,000 which is a significant part of the RFID cost; however, if the loss rate doesn't justify the expense, this brings the cost of the RFID implementation down considerably (from \$611,285 to \$401,285).

While RFID provides many advantages, top priority should go to installing the AMH systems at the two busiest libraries. RFID can always be implemented at a later date after tag prices have come down a bit more and after the standards issues have been completely resolved. While there are many benefits to implementing RFID immediately for both staff and customers, the crisis at Palo Alto resides at Main and Mitchell Park. AMH systems at these two locations will provide the greatest relief to these libraries, whereas RFID system-wide will provide a more generalized but less targeted benefit.

Finally, implementing a small automated check-in system with 3-bin sorter at Children's Library would benefit library staff and improve services there by allowing for more self-service options and immediate check-in of all library material. Installing AMH systems at Downtown and College Terrace is not recommended due to the small size and small circulation at these libraries. Central sorting was not considered an option because it would slow down the movement of material between the libraries and increase the volume and cost of the City's interlibrary courier service.

Hard Costs for a 9-bin Sorter at Main Library

The size of the sorter partly depends on the space that is available but it is likely that a 9-bin sorter could be designed for the current workspace or the newly remodeled work area (planned for after the new Mitchell Park Library opens). With the recommended 9-bin sorter and one self check-in system, nearly 1,400 items would be automatically checked in and sorted each day including material received in book drops and delivery.

We will assume the Library chooses high-capacity trolleys capable of holding 200 items¹⁸. Trolleys will be in place at five of the discharge locations. At the other four locations, delivery totes capable of holding 40 items will be used for sorting out material to be delivered to one of the other branches. Therefore, the storage capacity of the sorter is 1160. Theoretically, a staff person only needs to tend to the sorter when a trolley or tote needs to be swapped out. Because the various discharge locations will not fill evenly, we can assume that a tote or trolley will need to be swapped out by the time the storage capacity hits a certain threshold. For purposes of this analysis, we will use a threshold (or adjusted capacity) of half the storage capacity of the sorter (580 items).

In addition to the 9-bin sorter, the Main Library AMH system will have a staff induction station and at least one self check-in station. According to FKI Logistex budgetary estimates, the system would cost approximately \$285,000 to purchase and \$15,000 per year in maintenance.

¹⁸ The more discharges, the finer the sorting can be. It will require additional analysis to make the best choice between bins, trolleys and book carts when configuring the sorter. These decisions are made based on hourly circulation patterns at the library, number of discharges available, and number of staff available for shelving.

Hard Costs for 11-bin Sorter at new Mitchell Park Library

Annual circulation of 623,853 is equivalent to 12442 circulations per week. This indicates that Mitchell Park Library handles approximately 215 circulations per hour. With the recommended 11-bin sorter and one self check-in system in the library entryway to provide 24/7 access, nearly 1,800 items would be automatically checked in and sorted each day including material received in book drops and delivery.

We will assume the Library chooses high-capacity trolleys capable of holding 200 items¹⁹. Trolleys will be in place at seven of the discharge locations. At the other four locations, delivery totes capable of holding 40 items will be used for sorting out material to be delivered to one of the other branches. Therefore, the storage capacity of the sorter is 1560 items. Theoretically, a staff person only needs to tend to the sorter when a trolley or tote needs to be swapped out. Because the various discharge locations will not fill evenly, we can assume that a tote or trolley will need to be swapped out by the time the storage capacity hits a certain threshold. For purposes of this analysis, we will use a threshold (or adjusted capacity) of half the storage capacity of the sorter (780 items).

In addition to the 11-bin sorter, the new Mitchell Park Library AMH system will have a staff induction station and at least one self check-in station. According to FKI Logistex budgetary estimates, the system would cost approximately \$345,000 to purchase and \$20,000 per year in maintenance.

Hard Costs for 3-bin Sorter at Children's Library

With the recommended 3-bin sorter at Children's Library, over 800 items would be automatically checked in and rough sorted each day including material received in book drops and delivery.

Each of the three trolleys is capable of holding 200 items. No delivery totes will be used which means all material outbound for other branches will have to be scanned by staff.

The storage capacity of the sorter is 600. The adjusted capacity (half the storage capacity) of the sorter is 300.

In addition to the 3-bin sorter, the Children's Library AMH system will have a staff induction station and one self check-in station. According to FKI Logistex budgetary estimates, the system would cost approximately \$179,000 to purchase and \$9,000 per year in maintenance.

¹⁹ The more discharges, the finer the sorting can be. It will require additional analysis to make the best choice between bins, trolleys and book carts when configuring the sorter. These decisions are made based on hourly circulation patterns at the library, number of discharges available, and number of staff available for shelving.

Automated Materials Handling Costs

In addition to the costs of purchasing an AMH system, the ongoing costs of maintaining and staffing the system must be factored into any purchasing decisions.

Purchase Cost

The cost of purchasing and installing each of the three AMH systems under consideration is broken down in the table below. Budgetary pricing and engineering drawings for each of the systems have been provided by FKI Logistex and both the design and prices will vary from vendor to vendor.

Table 5: Summary of Purchase Costs and Components of AMH Systems

	Design, commissioning, installation, Hot Line Support, One Year Warranty	Additional Software Programming for Tote Check-in Capability	AMH System Components Included
Main	\$260,000	\$25,000	9-bin inline sorter, internal automated check-in, staff induction, 12 trolleys
Mitchell Park	\$320,000	\$25,000	11-bin inline sorter, 24/7 automated check-in, internal automated check-in, staff induction, 15 trolleys
Children's	\$154,000	\$25,000	3-bin inline sorter, staff induction, internal automated check-in, 5 trolleys

Ongoing Costs

The annual maintenance costs of an AMH system vary vendor by vendor. If a library has more than one system, the maintenance costs per system will be cheaper because the on-site maintenance work can be performed on all systems in one visit. Each AMH system from FKI Logistex (the vendor used to provide the estimates included in this document) comes with a 12-month parts warranty and hot line support. After the first year, FKI offers a preventative maintenance contract that includes annual, semi-annual or quarterly inspections and hot line support. The inspections cover routine maintenance and replacement parts such as belts, fuses, and CPU upgrades and the hot line support includes telephone support as well as remote support by engineers who can access the system over the Internet. Most libraries opt for more frequent inspections in the first year but are able to cut back to semi-annual or annual inspections afterwards. Therefore, the cost of support can vary quite a bit depending on how much of the maintenance can be performed by local staff after they've been trained.

FKI reports that their systems require very little support so they are in the process of reducing the price of their preventative maintenance contracts with their new systems. Based on estimates provided in July, 2008, maintenance contracts including 2 service visits per year and hotline support range from 5-7% of the cost of the system (the lower range applies to libraries with multiple sorters that can be serviced at once).

AMH systems have a long lifetime. Most first generation sorters provided by FKI are still in operation, 15-20 years later, and in most cases, the system components (CPU, chutes, conveyors, inductions stations) can be individually upgraded without replacing the entire system.

Staffing

Unless a library installs a very large system, it is not generally necessary to create a new position to manage it; the amount of actual staff time required is quite small. However, someone in circulation should be given primary responsibility for monitoring the sorter (matching holds slips to items, replacing full bins with empty bins, staging carts for shelvers, etc). What percentage of that person's time must be dedicated to staging and inducting material depends on circulation volume.

Fewer circulation staff will be required to handle the same volume of material but it will be up to the Library to determine how best to redistribute staff. The staff working in the back room will perform the following tasks:

1. induct material into the sorter²⁰ (returns that don't go into the automated check-in system and some items received via delivery)
2. remove material from bins and place on book carts (only needed if bins or trolleys are used instead of ready-to-shelve carts)
3. stage carts for shelvers
4. swap out full totes, bins and/or carts with empties (on the sorter)
5. place holds slips in the proper books and stage those for shelvers.

Depending on how many shelvers are available, it may be possible to use ready-to-shelve bookcarts (e.g. Ergo Carts) at the discharge locations instead of bins or trolleys. This eliminates one of the tasks required of the back room staff (remove material from bins) but it increases the frequency with which the ready-to-shelve carts must be swapped out. Planning the best sorter configuration for each Library requires evaluating the circulation patterns hour-by-hour and must be done with the AMH vendor.

In addition to circulation staff working with library material, one person needs to be in charge of performing routine maintenance on the sorter and should be trained by the AMH vendor to do this. As a mechanical system, these routine maintenance tasks are

²⁰ The time spent inducting material into the sorter (using the staff induction unit) takes up relatively little time. For example, when the new Mitchell Park Library opens, the daily circulation volume is expected to be 2,666 items. If back room staff had to induct every item circulated each day, they'd need to spend less than 20 minutes for each hour the Library was open (assuming an induction speed of 20 items per minute). However, most material will be inducted by the customer using the self check-in units and delivery items can be batch checked in using the tote check-in system. So the bulk of the time spent working in the backroom will be spent on the other staging and holds related tasks.

critical to keeping the system functioning 20 or more years. System upgrades are generally performed by the vendor and most vendors can also assist with monitoring the activities of each sorter to ensure proper function.

Often the facilities person is able to perform the routine maintenance tasks, the circulation supervisor (or someone on that team) is trained to manage the sorting program, and existing circulation clerks are used to induct material into the sorter and stage material. New staff are not generally required for managing the sorter. The tasks are usually assigned to existing staff.

A sorting system should have one staff person available (usually from circulation) for managing the software program that controls how items are discharged to each location because the sorting algorithm can be changed by library staff as conditions change. For example, how items are sorted and what kind of receptacle is staged at each sort location can be changed by staff trained to modify the program without requiring the vendor to come onsite or dial into the system. This task does not require a new dedicated position; however, the library will need to determine who is best suited for filling this role.

Libraries installing AMH equipment require many fewer hours of staff time to manage the same amount of material. Because the sorter is doing the sorting work, circulation staff find they are able to spend more time shelving material. In some cases, this means eliminating backlogs of material ready to be put back into circulation. For libraries like Palo Alto, where it can take up to two days to get a returned item back on the shelf, the sorter would allow for turnaround times of 1-2 hours depending on staffing. Libraries with AMH systems are able to handle a higher volume of material without adding staff and/or can reassign workers to new tasks that result in even better service for their library customers.

AMH and RFID Cost Savings and Benefits

AMH and RFID provide many benefits, both tangible and intangible, to library staff and customers. The most significant tangible benefit of installing AMH equipment is the ability to handle significantly higher volumes of material without the associated increase in staffing costs. While higher circulations will require additional staff for shelving, the process of checking in, sorting material, handling higher delivery volumes remain manageable by a small number of people staffing the system.

The most significant tangible benefit of installing RFID is reducing the need to grasp, pick up, and manipulate items during the check-in and check-out process. In addition to speeding up the process (for example by allowing staff to check out two or more items at a time, rather than having to scan each item individually), RFID reduces the potential for repetitive stress injuries.

In addition to these key benefits, AMH and RFID provide a number of significant benefits, some of which are clearly tangible, though it is difficult to measure the value in any rigorous way. These additional benefits are summarized later in this report.

Most libraries do not have the resources to rigorously count time spent on individual tasks, and so there are no reliable benchmarks for the amount of time spent on check-in and check-out, with or without AMH or RFID, at this time. Therefore, estimates of cost savings and payback periods are necessarily approximate.

Tangible savings occur primarily in the area of labor, as AMH and RFID dramatically reduce the number of times an item must be handled and scanned in the check-in and check-out processes. For example, if it takes about five seconds to scan an item, and AMH allows the library to eliminate one million scans per year, the associated labor savings could be as many as 1,388 hours per year. However, it is difficult to evaluate whether all five seconds are actually being saved for each scan, and whether the time saved can actually be effectively used on other tasks.

This difficulty is especially acute when tasks are not eliminated altogether, but just made easier. For example, to measure the labor savings delivered by RFID at the customer service counter during check-out, one must know the number of items a customer typically checks out at one time, in order to estimate how much time is saved by scanning multiple items in one pass. In addition, the amount of time spent checking out items will be significantly affected by how much time it takes to answer customer questions, offer additional services such as item renewal, etc. – tasks which are often completed at the same time as materials are checked out.

Assumptions Affecting Payback Periods

In order to determine a payback period for AMH equipment based on hard costs, assumptions must be made about circulation trends, percentage of users who will use the self-service equipment and cost of living increases. Forecasting circulation can be particularly challenging because so many factors can come into play. For example, one big increase (11%) was between 2001-2002 and 2002-2003 when the loan period was reduced from four weeks to three weeks, a charge was eliminated for placing holds and the ability to place holds on “In” items was introduced. Conversely, between 2003 and 2005, circulation dropped by 2% and then held steady the next year. Overall, circulation has increased by 50% over the last 10 years.

Several factors are likely to result in continued circulation increases. The primary contributor will be the new Mitchell Park Library. Any time a library adds a new library or remodels an existing one, circulation is significantly increased system-wide. This is due to the larger capacity of the new library and the new customers that the new building draws to the system. Adding highly desirable services also increases circulation. For example, libraries report significant bumps in circulation (and especially in interlibrary delivery demand) after introducing self-service holds. Adding more DVD titles, as the Library did in 2005-2006, also increases circulation.

Assuming the Library continues to make choices that are responsive to community demand, it is safe to assume that circulation will continue to increase. For the purposes of our projections, we assume a modest increase of 3% each year with some exceptions. The year that the new Mitchell Park Library opens, the Library assumes an increase of 50% to reflect the effect of the larger library and collection size and the effect of publicity associated with opening a new building. After opening, annual increases of 5% are

assumed for four years before settling at the standard 3% increase. Because of the slowing growth in the Children's Library service area (based on the Library's demographic analysis), we assume Children's Library circulation increases for three years but then flattens.

Another assumption is the wage and cost of living increases for circulation staff. Based on current costs of circulation staff (including wages and a cash stipend in place of medical coverage), and the approximate percentage increase used by the City Budget Division, the Library suggests calculating circulation staff wages for 2007/2008 at \$24/hour, increasing annually by 3%.

AMH Cost Savings and Payback Periods

In order to provide useful estimates of cost savings and payback periods, this report uses a conservative approach of estimating savings in one area – the check-in process. Potential savings in other areas are mentioned but not included in the payback period calculations. In addition, rather than attempting to count cost savings per check-in, this report counts the amount of time that an automated check-in station needs to be staffed, and compares that to the amount of time currently spent on check-in processes. Calculating the difference in actual staffing time provides a more realistic measure than counting the number of seconds saved per transaction.

The AMH equipment handles the entire check-in, triggering of holds (if applicable) and sorting process. For interlibrary delivery items, each tote needs to be removed from the sorter once it is full, but no handling of individual delivery items is required until the final step of reshelving items. In short, the check-in process goes from a labor-intensive process of checking-in, sorting, and processing items for shelving and holds delivery, to a less labor-intensive process of monitoring the automated check-in station and moving totes of books to the appropriate cart as the sorting bins reach capacity. As the tables in Appendices 5-7 show, the latter process occupies a fraction of the time the check-in station is running, which frees staff to work on other unrelated tasks.

Using circulation statistics and forecasts, and estimates of staff time spent on checking-in materials as provided by the Library, we calculate the amount of time staff must be available to induct returned materials into the sorter, monitor sorter capacity, and move sorted books to shelving carts, as follows:

1. Calculate the average number of items checked in per hour.
2. Calculate the average number of hours it will take for the sorter to become half full. (Since individual bins will full at different rates, we assume at least one bin will need to be emptied by the time the sorter is half full.)
3. Assuming that a staff person needs to work one hour each time a bin becomes full, calculate the number of hours of staff time required every week. (One hour of work is actually a generous estimate, since emptying a bin takes only minutes, and inducting new material into the sorter takes less than two-thirds of the time we have allowed, even if we assume that customers do not do any self-induction of materials.)
4. Calculate the difference in labor costs between manual check-in and AMH check-in.

5. Subtract AMH costs and calculate total savings.

Appendix 4 provides detailed descriptions of how the payback periods have been calculated. Appendices 5-8 provide a breakdown of the results of these calculations at Main (Appendix 5), Mitchell Park (Appendix 6), Children's Library (Appendix 7) and overall payback period including RFID implementation (Appendix 8). The payback period for installing AMH systems (and not including RFID costs) at the three locations included in the recommendations is as follows:

- Main Library, with a nine-bin sorter, has a payback period of less than four years, or by the end of fiscal year 2016/17 (Appendix 5).
- Mitchell Park Library, with an 11-bin sorter, has a payback period of less than three years, or by the end of fiscal year 2014/15 (Appendix 6).
- Children's Library, with a three-bin sorter, has a payback period of less than seven years, or by the end of fiscal year 2017/18 (Appendix 7).
- Taken as a whole, the three libraries will achieve payback less than five years after the first system is installed, or by the end of fiscal year 2015/16 (Appendix 8).

RFID Cost Savings and Payback Period

Implementing any AMH system requires some preparation of materials to ensure that each item being sorted has a readable bar code or RFID tag. As noted earlier, RFID tags are much more expensive than bar codes but they offer benefits that should be taken into account. The cost of addressing the bar codes for the Palo Alto Library are not significant (approximately \$40,000), whereas the cost of implementing RFID is significant (almost \$400,000 to over \$600,000).

It is very difficult to quantify the savings associated with RFID because the tags don't eliminate steps in the handling of material; each step is just made easier. There is less lifting, grasping, and opening of cases and book covers for both staff and public users. Staff and customers can eliminate individual scans by scanning several items at once. Most libraries find they can handle significantly higher volumes of material with the same amount of staff. And while there are no studies to prove it, most libraries that have converted to RFID believe that the ergonomic benefits have reduced repetitive stress injuries to staff.

This report does not attempt to calculate a specific payback period for RFID, other than to note that taken in combination with AMH at all three locations, the entire system has a payback period of less than seven years from the date the first AMH system is installed. The payback period is seven years if security gates are not included (eight years if security gates are included). Details of the calculation are shown in Appendix 8.

Intangible Benefits of AMH Systems

The combination of AMH and RFID will eliminate the repetitive motion of hundreds of thousands of scans per year and reduces the number of times items need to be picked up and handled by circulation staff. For example, items returned to book drops or at the automated check-in system that need to be delivered to another library would not need to

be picked up, opened, or transferred in any way by circulation staff (except possibly for media which may still need to be visually verified).

Holds processing will be significantly streamlined because all items passing through the sorter that trigger a hold will be routed to a discharge location and the holds slip will be printed out and ready for attaching to each item. This will result in much faster return-to-shelf times and better service for customers.

Each day, hundreds of items will be checked in, sorted and back on the shelf within a few hours instead of two days because existing staff can be reallocated to shelving work instead of sorting and check-in.

Another benefit of the AMH system is the self check-in that allows customers to remove items from their account before picking up additional material. Customers are increasingly frustrated by the fact that returned items can take hours to be checked in which means they are prevented from borrowing new material due to the Library's inability to keep up with returns. In this fast-paced world of instant gratification, customers don't understand why their returns can't be instantly registered so they are free to borrow to the Library limits once again. With automated check-in, their expectations are met without requiring staff to handle the transaction.

Each of the AMH systems is configured with tote check-in capability which means that each delivery tote sent out from one of the libraries with an AMH system will have a tote manifest associated with it so that a single scan of the tote bar code will be used to process all 35-50 items inside the tote. Rather than checking in each item in the tote at the receiving library, each tote can be scanned once. Because Main and Mitchell Park are significantly more busy than the other libraries, this means that a high percentage of totes can be checked in this way. This is a significant benefit for the entire system, especially those libraries with no automated check-in system installed.

Customers also expect items returned by other customers to be immediately available to them. Many libraries report that customers watch the progress of items they've placed on hold and arrive at the Library to pick up their requested items within hours (sometimes minutes) of receiving notice that their item is available. With an automated check-in system, the material can actually be waiting for them when they arrive.

Library staff can perform inventory (or shelf reading) quickly and easily, ensuring that materials are shelved correctly. This reduces the amount of time staff spend searching for and pulling items to fill holds, and increases customer satisfaction in finding materials on the shelf. Improved inventory control also helps the Library detect and control loss of materials more effectively.

Table 6: Summary of Intangible Benefits

Area/Technology	Staff	Customer
Holds	Less handling, holds slip automatically printed	Faster turnaround time so material is ready for pick-up within minutes of it being returned.
Delivery	Less handling, less scanning of individual items with tote check-in capability	Faster turnaround time for holds and returns. Holds are triggered automatically during sorting and available to waiting customer sooner. Popular material back on the shelf quicker.
Returns	Less handling, scanning of items eliminated when self check-in machine used	Faster turnaround time for returns. Holds are triggered automatically during sorting and available to waiting customer sooner. Popular material back on the shelf quicker.
Personal Service	Staff working in back room can be redeployed to public service areas	Customer has more contact with staff who can provide personalized assistance
Check-in	Check-in largely eliminated from staff workflow	Customer's items are taken off account as soon as items are returned so can borrow up to limit again. Option to print check-in receipt.
RFID	Eliminates picking up items because material can be slid over reader recessed in desktop. Multiple items can be read simultaneously.	Self check-in and self check-out easy for customers because the orientation of the book doesn't matter. Multiple items can be read simultaneously
Inventory control	Allows staff to inventory materials on shelves quickly and easily and spend less time searching for mis-shelved items.	Customers are able to find correctly shelved items more consistently.

Proposed Implementation Plan

If the Library chooses to move forward with RFID in combination with the AMH recommendations at Main, Mitchell Park and Children's Library, the RFID tagging of the collection should be the first step in the process. The plan to double the Mitchell Park

collection means that the work of tagging could be higher than the estimates provided in this document because the current collection size (not the planned collection size) was used. All new materials, starting with the new Mitchell Park material, should be tagged by the materials vendors. This will alleviate at least some of the work of implementing RFID at Mitchell Park.

Because all the material currently part of the Mitchell Park collection will have to be moved (at least twice) as part of the building project, tagging the current collection as part of that process would be ideal.

Before any current inventory is tagged, the entire collection should be weeded to ensure that time and money is not spent on material that is going to be eliminated from the collection in the next six months.

Once weeded, the remaining collection should be tagged with two teams of three people. The three people working on the tagging operation can be library staff rotating in and out so that everyone has some involvement in the operation. This ensures that everyone feels a part of the project, allows staff to become familiar with the technology and provides opportunities for identifying staff most efficient at this particular process. However, since allocating current staff to this level of work is unfeasible due to current staff workloads, the Library may need to hire temporary staff to complete the tagging project. Assuming the Library can keep two teams of three tagging for at least 30 hours per week, the entire collection could be tagged in 15-20 weeks.

Once the collection is tagged, several steps can be taken simultaneously including configuring each service desk with readers (in place of or in addition to bar code scanners), retrofitting self check-out machines to work with RFID tags, and designing the AMH installations.

Incorporating RFID readers in circulation areas may require more than adding tag readers at each desk. In most cases, RFID readers can simply be mounted underneath the service desk so that tags are read through the desk (up to 8-10" from the items). Unless the Library service desks are made of certain metals, installing the RFID readers is very straightforward. However, in order to truly benefit from the ergonomic benefits of having an RFID tagged collection, the Library should consider using this opportunity to make other workstation changes that would optimize circulation and materials handling.

The AMH systems can be installed fairly quickly once the systems have been designed and the space for the system has been prepped. AMH installation (self check-in and sorter) at Main can begin as soon as the tagging is complete; however current plans call for waiting until Main is remodeled (which is scheduled to happen after the new Mitchell Park Library is opened). Prior to completing remodel plans, an analysis of the circulation patterns should be done so that sizing and configuration of the sorter can be determined. Children's Library has been recently remodeled and the current backroom and one of the book drops will be an easy conversion to the AMH system recommended. This would be a good location for pilot testing all of the components of the new system including the tote check-in capability and automatic holds printing features.

In the case of Mitchell Park, the system should be installed prior to opening. The current space allows for a 13-bin sorter although this might make the designated Returns area more crowded than is ideal (see Appendix 3: New Mitchell Park Library AMH Design). Therefore, before building plans are finalized, it is recommended that the Library work closely with the AMH vendor to determine the number of discharges and types of bins that are required given the circulation volume anticipated and the staffing available for feeding material into the sorter, preparing holds and shelving returned material.

Table 7: Timeline of Proposed Implementation Plan

Tasks	Duration	Who	Notes
Select AMH and RFID vendor(s)	12 weeks	Library	Recommend single RFP for RFID based AMH project
Arrange for tagging of all new material	2 weeks	Library with RFID vendor	Contact all materials vendors and provide specs for library RFID tags to be applied on new material
Weed	5 weeks	Library	Review collection development and circulation policies to determine what really needs to be tagged
Outsource tagging to Vendor, or form tagging teams and tag collection	25 weeks	Library	The duration will likely be longer if the Library chooses to do the tagging. If the Library chooses to do the tagging in house, it will be important to establish a strategy for involving the staff in the work effort which may include overtime or using substitutes (or outsourcing). RFID vendor will need to work with Library to make sure the workflow is efficient and all conversion equipment is in place; vendor will assist with QC.
Replace bar code scanners with tag readers at service desks	2-8 weeks	Library with RFID vendor	May not be as simple as replacing scanners with readers because service desks may need to be retrofit to provide maximum ergonomic benefits. Also, barcode scanners will continue to be needed as backup on service desks.
Retrofit all self check-out machines	5 weeks	Libramation	Self check-out vendor should be able to do this without much (if any) library assistance
Install AMH at Children's and pilot test advanced features	8 weeks	Library with AMH vendor	Because of the layout of this library, installing the AMH and self check-in system should be very straightforward. Pilot test tote-checkin and automatic holds printing capabilities of

			AMH vendor and identify any issues with ILS
Design Mitchell Park AMH system	8 weeks	Library with AMH vendor	Design AMH system for the new building
Install AMH system at Mitchell Park	4 weeks – 25 weeks	Library with AMH vendor	Library, AMH vendor and building contractors will need to coordinate installation with other construction activities
Design Main Library AMH system	8 weeks	Library with AMH Vendor	Analyze Main circulation patterns and work with AMH vendor to design system that will suit the library's needs and fit into the current available space
Install AMH at Main	6 weeks	Library with AMH vendor	While the installation and set-up will only take a couple weeks, the work of getting the space ready (moving walls, addressing electrical issues) could require more time.
Perform quarterly inventories	1 week each	Library	This should be done to determine the loss rate of library material and to improve synchronization between catalog and holdings
Decide about security gates	10 weeks	Library with RFID vendor	Library may choose not to install security gates at all or to install at select locations.

Conclusion

Palo Alto City Library faces a common challenge – more demand for library material than ever before, and customers that want the material made available to them quickly and conveniently. The Library circulation is steadily increasing, hitting an all-time high of over 1.5 million circulations in 2007/8. Circulation is likely to increase even more dramatically because the Library recently joined Link+. Other libraries joining Link+ have had to dedicate an additional 17-20 hours a week of staff time just to process Link+ requests.

With approval of the library construction bond measure in 2008, a new Mitchell Park Library will be built. The new library will be four times the size of the current library and will add 56,000 new print items and 14,000 new A/V items to the Library collection. This will not only increase the workload dramatically at Mitchell Park, but it will increase materials movement through the Palo Alto system.

AMH systems for Mitchell Park, Main and Children's Library have been recommended and the reasons for this recommendation are provided. The AMH systems recommended at each library includes a library sorter with staff induction as well as an automated self check-in machine. Such an AMH system eliminates the need to handle any material that needs to be routed to other libraries, eliminates the manual scanning of all items ready for shelving and rough sorts them, and allows for automatically printing holds slips.

AMH systems, in combination with RFID, create improvements system-wide for both the staff and the public. Check-in and check-out is easier when bar codes don't have to be located on the item (RFID readers read the RFID tags through the covers and cases because they are based on radio wave technology, not optical technology). In addition, multiple items can be scanned at once, unlike bar codes which require each individual bar code to be read one at a time. RFID also makes inventory control easier and provides the Library with the ability to evaluate their loss rate in order to determine whether security gates are justified.

The recommendation is for the Palo Alto Library to proceed with RFID tagging of its entire collection and then proceed to hire an AMH vendor who will work with them to design systems appropriate for their libraries. A new AMH system can be installed at Main in the current location but a larger system should be considered for the newly remodeled workspace at Main. While an 11-bin sorter will fit into the materials handling space in the new Mitchell Park design, a larger system that allows for finer sorting of customer returns may be beneficial so this should be analyzed in consultation with the AMH vendor. A small, 3-bin sorter with automated check-in system is recommended for Children's Library as well.

Once the RFID system has been in place for some time, an analysis should be performed to determine whether the loss rate justifies the additional price tag of \$210,000 for security gates. The total cost for the AMH and RFID implementation, without security gates, is estimated at \$1,210,285 with annual maintenance costs of \$65,250. The entire system will pay for itself within seven years.

The AMH systems will provide opportunities for more streamlined operations at all libraries, reduce shelving backlogs, increase turnaround time of circulated items, and create opportunities for customer service improvements. All circulation and materials handling transactions can be performed more easily with RFID than with bar codes and this benefits library staff as well as customers. RFID is recommended because it provides security and inventory control benefits and will make all circulation transactions quicker and easier for library customers and staff.

Appendices

Appendix 1: Sorter Induction Units and Discharges

Appendix 2: Total Capital and Annual Costs of Recommended System

Appendix 3: New Mitchell Park Library AMH Design

Appendix 4: Explanation of Payback Period Calculations

Appendix 5: Costs and Projected Payback Period for recommended AMH at
Main Library

Appendix 6: Costs and Projected Payback Period for Recommended AMH at
New Mitchell Library

Appendix 7: Costs and Projected Payback Period for Recommended AMH at
Children's Library

Appendix 8: Projected Costs and Payback Period for Overall Project (AMH
and RFID)