

Library Management System

ClearSpecs Model

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A. Product Abstract

A1. Abstract of Library Management System

Comment: High-level summary of the product being specified

Consider a library database with the following transactions:

1. Check out a copy of a book / Return a copy of a book;
2. Add a copy of a book to / Remove a copy of a book from the library;
3. Get the list of books by a particular author or in a particular subject area;
4. Find out the list of books currently checked out by a particular borrower;
5. Find out what borrower last checked out a particular copy of a book.

There are two types of users: staff users and ordinary borrowers. Transactions 1, 2, 4 and 5 are restricted to staff users, except that ordinary borrowers can perform transaction 4 to find out the list of books currently borrowed by themselves. The database must also satisfy the following constraints:

1. All copies in the library must be available for checkout or be checked out.
2. No copy of the book may be both available and checked out at the same time.
3. A borrower may not have more than a predefined number of books checked out at one time.
4. A borrower may not checkout more than one copy of a book

[This is the original problem statement.]

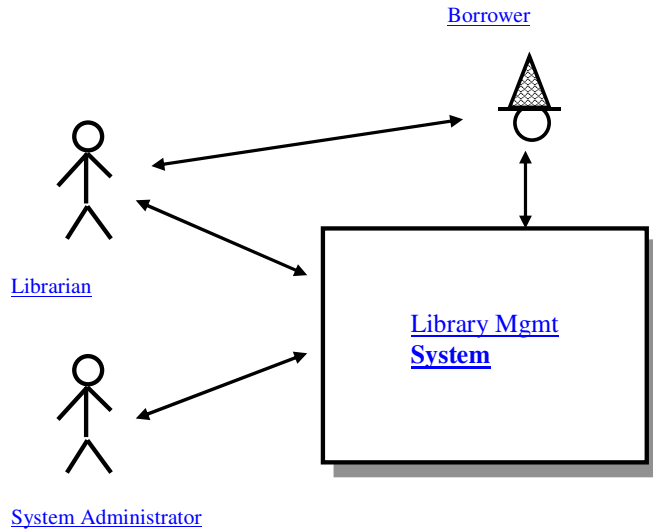
In addition, there is a subsystem that takes a retinal scan of a potential borrower and scans the bar code on a copy in order to enable automatic check out and return.

“Problem Set for the Fourth International Workshop on Software Specification and Design”
Fourth International Workshop on Software Specification and Design April 3-4 1987 Monterey CA
IEEE Computer Society Press

B. User Population

B1. User Population Diagram

Comment: Diagram of user population – standard use case model component



B2. User Profiles

Comment: Table of attributes for each actor

- a. System Administrator
- b. Librarian
- c. Borrower

B2a. System Administrator Profile

Attribute Group	Attribute	System Administrator
	Category (Role or Responsibility)	Role
	Primary Responsibilities	To administer system
	Locations	Administration Office
Relationships	Supports	Staff & Borrowers
	Subclass of	Staff
	Subclass of	Borrower

B2b. Librarian Profile

Attribute Group	Attribute	Librarian
	Category (Role or Responsibility)	Role
	Primary Responsibilities	To administer library collection
	Locations	Library Departments
Relationships	Supports	Borrowers
	Subclass of	Staff
	Subclass of	Borrower

B2c. Borrower Profile

Attribute Group	Attribute	Borrower
	Category (Role or Responsibility)	Responsibility -- Person may be outside user or staff
	Primary Responsibilities	To utilize library resources
	Locations	Borrower areas
Relationships	Supported by	Librarian
	Superclass of	Staff

Borrower Types

- Borrower
 - Non-staff
 - Staff
 - Librarians
 - System Administrators

C. Application Domain

- C1. [Entity Profiles](#)
- C2. [Entity-Relationship Table](#)
- C3. [Entity Constraints](#)

C1. Entity Profiles – Basic attributes of essential classes

Comment: Tables of basic and derived attributes for the entities in the application domain

- a. [Books](#)
- b. [Copies](#)
- c. [Sessions](#)
- d. [Borrowers](#)
- e. [Staff](#)

C1a. Books Profile

Class Name	Attribute Name	Attribute Description	Value Name	Value Type & Ranges	Attribute Identifier
Book	Book Id			ISBN No.	At01
	Title			AN (35)	At02
	Author List	Array of author names		Array	At03
	Subject List	Array of subject names		Array	At04
	Publisher Id				At05
	Publication Date			Date	At06
	Size Code		Reg Over	Regular Oversize	At07
	Current Copy Count			Integer	At08

C1b. Copies Profile

Class Name	Attribute Name	Attribute Description	Value Name	Value Type & Ranges	Attribute Identifier
Copy	Book Id	Supertype Identifier		ISBN No.	At01
	Copy Id				At02
	Supplier Id				At03
	Acquisition Date			Date	At04
	Checkout Period	# of days copy can be loaned to a borrower		Integer	At05
	Loaned Count	# of times copy has been loaned to a borrower		Integer	At06
	Availability Status		NonEx Avail ORes CRes Out Fix Gone	NonExistent Available OpenReserve ClosedReserve OnLoan InRepair Removed	At07
	Availability Status Start Date			Date	At08
	Borrower Id				At09
	Unavailabler Id	Id of agent (borrower or staff) creating non-avail status		Staff or Borrower Id	At10

C1c. Sessions Profile

Class Name	Attribute Name	Attribute Description	Value Name	Value Types & Ranges	Attribute Identifier
Session	Terminal Id				At01
	Start Moment			Date & Time	At02
	End Moment			Date & Time	At03
	Initiator Id				At04
	Initiator Password				At05
	Security Level		Staff Admin	Staff Administrator	At06

C1d. Borrowers Profile

Class Name	Attribute Name	Attribute Description	Value Name	Value Type & Range	Attribute Identifier
Borrower	Borrower Id				At01
	Borrower Password				At02
	Staff Id				At03
	Name				At04
	Address				At05
	Phone				At06
	E-mail				At07
	Borrow Limit			Integer	At08
	Current Borrow Count			Integer	At09
	Borrow List	Array of borrowed copies		Array	At10
	Unpaid Fines			Dollar amount	At11

C1e. Staff Profile

Class Name	Attribute Name	Attribute Description	Value Name	Value Types & Ranges	Attribute Identifier
Staff	Staff Id				At01
	Staff Password				At02
	Security Level		Staff Admin	Staff, Administrator	At03
	Name				At04
	Address				At05
	Phone				At06
	E-mail				At07
	Job Title			Librarian, Administrator	At08

C2. Entity-Relationship Table

Comment: Table specifying relationships between individual entities in the application domain

Class Name	Related Class	Relationships	Multiplicity
System	Sys Adm	Started by, Stopped by	1:M
Sys Adm	Staff	Subclass of	
	Staff	Adds, Removes	1:M
	Staff	Updates	M:M
	System	Starts, Stops	M:1
Librarian	Staff	Subclass of	
	Borrower	Adds, Removes	1:M
	Borrower	Updates	M:M
	Book	Adds, Removes	1:M
	Book	Changes	M:M
	Copy	Adds, Removes	1:M
	Copy	Changes, Repairs, Reserves, Restores, Loans, Returns	M:M
Staff	Borrower	Subclass of	
	Librarian	Superclass of	
	Sys Adm	Superclass of	
	Sys Adm	Added by, Removed by	M:1
	Sys Adm	Updated by	M:M
	Session	Initiates, Terminates	1:M
Borrower	Staff	Superclass of	
	Copy	Borrows, Returns	M:M
Book	Copy	Instantiated by	1:M
	Librarian	Added by, Removed by	M:1
	Librarian	Changed by	M:M
Copy	Book	Instantiates	M:1
	Borrower	Borrowed by, Returned by	M:M
	Librarian	Added by, Removed by	M:1
	Librarian	Changed by, Repaired by, Reserved by, Restored by, Loaned by, Returned by	M:M
Session	Staff	Initiated by, Terminated by	M:1

C3. Entity Constraints

Comment: Specifications of "must be" facts about or relationships between attribute values

For any copy,

Status not = (Avail nor Out)

→ There is a librarian such that Unavailable Id = Staff Id

{ Only librarians can reserve, fix, or remove copies }

For any two copies (1 & 2) of a single book,

Book Id1 = Book Id2 &

Status of 1 = Status of 2 = Out

→ Borrower Id1 not = Borrower Id2

{ A single borrower may only borrow one copy of a book }

For any borrower,

$0 \leq \text{Currently Borrowed count} \leq \text{Borrow limit}$

{ A borrower may not borrow more than a defined number of copies }

Total # copies (i.e., current inventory)

= (# available copies + # open reserve copies + # closed reserve copies
+ # onloan copies + # inrepair copies)

Total of all current borrow counts = # onloan copies

Total size of all borrow lists = # onloan copies

For any session,

There is a staff member such that Staff Id = Initiator Id

{ Only staff can initiate a session }

D. Action Contract Expressions

D1. Product Reactions

Symmetric State Table for Copy Status

Part 1 or 2

Initial Status	Actors	Request Triggers	PostConditions	Final Status
NonEx or Gone	Librarian	OK Add Request	& Copy object added & Copy loaned count = 0 & Book copy count up 1	Avail
Ores or Cres or Fix	Librarian	OK Restore Request		Avail
Out	Librarian or Borrower	OK Manual or OK Auto Return Request	& Borrower current borrow count down 1	Avail
			Common Conditions: Copy status start date = today & Copy availabler id = Staff or Borrower id & Successful <u>action</u> msg returned	

Part 2 of 2

Initial Status	Actors	Request Triggers	PostConditions	Final Status
Avail	Librarian or Borrower	OK Manual or OK Auto Borrow Request	& Copy loaned count up 1 & Borrower current borrow count up 1	Out
Avail or CRes or Fix	Librarian	OK Open Reserve Request		ORes
Avail or ORes or Fix	Librarian	OK Closed Reserve Request		CRes
Avail or ORes or CRes	Librarian	OK Repair Request		Fix
Avail or Out or ORes or CRes or Fix	Librarian	OK Remove Request	& Book copy count down 1	Gone
			Common Conditions: Copy status start date = today & Copy unavailabler id = Staff or Borrower id & Successful <u>action</u> msg returned	

E. Precise Use Cases

E1. Single-Goal Cases

Comment: Use cases for individual product functions

System Administrator (SA) Activities

System requests

- a) Start system
- b) List sessions
- c) Stop system

Staff requests

- d) Display staff
- e) List staff
- f) Add staff
- g) Update staff
- h) Remove staff

Librarian Activities

Session requests

- i) Sign-on
- j) Sign-off

Manual borrow requests

- k) [Manual borrow copy](#)
- l) Manual return copy

Copy management requests

- m) Add copy
- n) Change copy
- o) Remove copy
- p) Repair copy
- q) Reserve copy
- r) Restore copy
- s) Locate copies
- t) List copies, borrowed by another, by first author
- u) List overdue copies by duration, then borrower name

Book management requests

- v) Display books
- w) Add book
- x) Change book
- y) Remove book

Borrower management requests

- z) Display borrowers
- aa) List borrowers
- bb) Add borrower
- cc) Update borrower
- dd) Remove borrower

Borrower Activities

Automatic borrow requests

- ee) Auto borrow copy
- ff) Auto return copy

List book requests

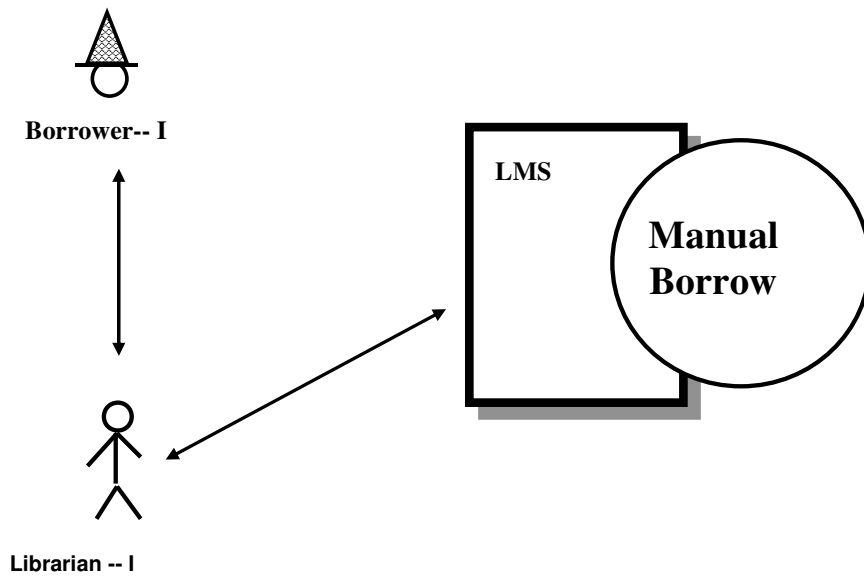
- gg) List books by first author
- hh) List books by subject

List my borrowed request

- ii) [List copies, borrowed by me, by first author](#)

E1k. Manual borrow copy

1) Use Case Diagram



2) Risk Factors

Frequency of occurrence: ranges from 4 to 20 per hour

Impact of failure:

likely case – **medium**, when automated borrow working
worst case – **high**, otherwise

3) Case Conditions

Invariants:

For librarian, Availability status = available

Preconditions:

For LM System, status = fully operational

For librarian, System access status = signed-on

For scenario, $0 < \text{Borrow count}$ (i.e., one or more copies to be borrowed)

4) Interactions

Success Course:

Borrower	Manual Borrow Subsystem	
	Librarian	LM System
ENTER 1. requests check-out and provides borrower card		
	2. requests check-out and provides borrower id	
		3. approves borrower, unless a. borrower id invalid b. borrower at borrow limit
4. provides copies		
	5. If (copy desired) enters next copy id Else withdraws copy Endif	
		6. records next borrow ¹ , unless a. copy id invalid b. copy is unavailable c. borrower at borrow limit d. borrower already borrowing book
	Until all copies are recorded or withdrawn, actors repeat 5 to 6	
	7. returns borrower card and borrowed copies SUCCESS EXIT	

Notes:

- 1) See behavior rules

Success Course Conditions

Invariants:

- For librarian, Availability status = available
- For borrower, Borrower Id is valid
- For borrower, $0 \leq \text{Currently Borrowed count} \leq \text{Borrow limit}$
- For each copy, Copy Id is valid

Preconditions:

- For scenario, $0 < \text{Borrow count}$
- For each copy to be borrowed, status = available
- For each copy to be borrowed, Borrower not already borrowing book
- For borrower, $(\text{Currently Borrowed count} + \text{Borrow count of scenario}) \leq \text{Borrow limit}$

Post-conditions:

- For each borrowed copy, status is out & Borrower borrowing book

Alternative Courses:

Exception Handlers (EH):

EHM1 - not “approves borrower”

EHM1 Invariants: <exception condition>

EHM1 Preconditions: None

Exception Handling Macro EHM1

Borrower	Manual Borrow Subsystem	
	Librarian	LM System
		1. reports <exception condition>
	2. reports <exception condition> and offers advice FAILURE EXIT	

EHM1 Post-conditions: <exception condition> reported
and advice offered to borrower

EHM1 applies to:

EH1 – BP 3a: invalid borrower id

EH2 – BP 3b: borrower at limit

EH3 – 7a

EH3 Invariants: Borrower is approved

EH3 Preconditions: Copy id is invalid

Borrower	Manual Borrow Subsystem	
	Librarian	LM System
		1. reports invalid copy id
	2. reenters copy id	
		3, If (copy id is valid) <i>Post-cond</i> – Copy id approved CONTINUE Else Reports copy id still invalid Endif
	4. withdraws copy and explains problem <i>Post-cond</i> – Copy withdrawn & problem explained to borrower ITERATE	

EHM2 - not “records next borrow”

EHM2 Invariants: <exception condition> and
 borrower is approved and
 copy id approved

EHM2 Preconditions: None

Exception Handling Macro 2

Borrower	Manual Borrow Subsystem	
	Librarian	LM System
		1. reports <exception condition>
	2. withdraws copy and explains problem ITERATE	

EHM2 Post-conditions: Copy withdrawn & problem explained to borrower

EHM2 applies to:

EH4 - BP 7b: copy unavailable

EH5 - BP 7c: borrower at borrow limit

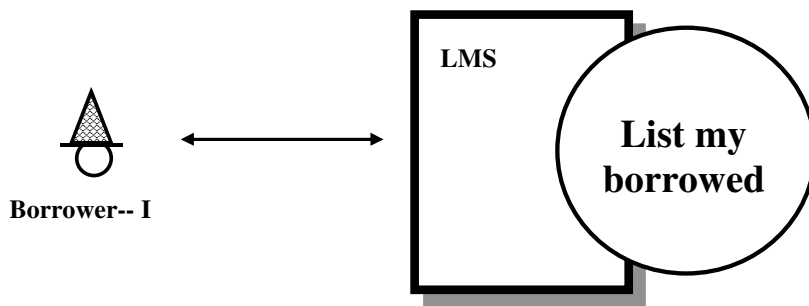
EH6 - BP 7d: borrower already borrowing a copy of the book

5) Behavior Rules

Initial Status	Actor	Request	Post-Reaction Conditions	Final Status
Avail	Librarian or Borrower	OK Manual or OK Auto Borrow Request	Loaned count increased by one & Copy status start date = today & Copy borrower id = Borrower id & Copy unavailabler id = Librarian id & Borrower current borrow count increased by one & Copy added to Borrow list & Successful borrow msg returned	Out

E1ii. List Copies, borrowed by me

1) Use Case Diagram



2) Risk Factors

Frequency of occurrence: ranges from 0 to 4 per hour with an average of 1

Impact of failure:
likely case – **low**
worst case – **low**

3) Case Conditions

Invariants:
None

Preconditions:
For LM System, status = fully operational
For borrower, System access status = signed on

4) Interactions

Success Course:

Borrower	LM System
ENTER 1. requests list of borrower's borrowed copies, choosing from a. menu selection b. keyboard shortcut	
	2. displays list of borrowed copies SUCCESS EXIT

Success Course Conditions

Invariants:

For LM System, status = fully operational

For borrower, System access status = signed on

Preconditions:

None

Post-conditions:

List of borrower's borrowed copies is displayed on borrower's terminal

E2. Multiple-Goal Cases

Comment: Use cases for sequences of product functions

System Administrator Activities

- a) Start system, List staff, Add staff, List staff, Display current staff, Update staff, Remove staff, List staff, List sessions, Stop system

Librarian Activities

- b) Sign-on, Add borrower (5 times), List borrowers, Display borrower, Update borrower, Remove borrower, List borrowers, Sign-off
- c) Sign-on, Add book (7 times), List books by first author, Display book, Change book (2 times), Remove book, List books by first author, Sign-off
- d) Sign-on, Add copy (5 times), [List all copies], Display copy, Change copy, Display copy, Remove copy, Display copy, Repair copy, Display copy, Reserve copy, [List all copies], Display copy, Restore copy, List copies, borrowed by another, by first author, List overdue copies by duration, then borrower name, [List all copies], Sign-off
- e) Sign-on, Manual borrow copy (5 times), Manual return copy (2 times), Manual borrow copy, Sign-off
- f) Mixture of borrower, book, copy, and manual borrow activities

Borrower Activities

- g) Sign-on, [List all copies], Auto borrow copy (5 times), [List all copies], Auto return copy (3 times), [List all copies], Sign-off
- h) Sign-on, List books by first author, List books by subject, List copies, borrowed by me, by first author, Sign-off