

**Laboratory Information Management System  
For Faculty of Information Technology**

**A thesis submitted to the faculty of information technology in partial  
Fulfillment of the requirement for the degree  
Master of Science (ICT)  
universiti utara Malaysia**

**By**

**Said Moh -E. Ahmed**

**© Said Moh -E. Ahmed, 2007. ALL rights reserved**



**PUSAT PENGAJIAN SISWAZAH**  
**(Centre For Graduate Studies)**  
**Universiti Utara Malaysia**

**PERAKUAN KERJA KERTAS PROJEK**  
**(Certificate of Project Paper)**

Saya, yang bertandatangan, memperakukan bahawa  
(I, the undersigned, certify that)

**SAID MOH-E. AHMED**

calon untuk Ijazah  
(candidate for the degree of) **MSc. (Information Communication Technology)**

telah mengemukakan kertas projek yang bertajuk  
(has presented his/her project paper of the following title)

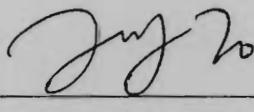
**LABORATORY INFORMATION MANAGEMENT SYSTEM FOR**  
**FACULTY OF INFORMATION TECHNOLOGY (LIMS) (FIT)**

seperti yang tercatat di muka surat tajuk dan kulit kertas projek  
(as it appears on the title page and front cover of project paper)

bahawa kertas projek tersebut boleh diterima dari segi bentuk serta kandungan  
dan meliputi bidang ilmu dengan memuaskan.  
(that the project paper acceptable in form and content, and that a satisfactory  
knowledge of the field is covered by the project paper).

Nama Penyelia Utama  
(Name of Main Supervisor): **MRS. JULIANA WAHID**

Tandatangan  
(Signature)

: 

Tarikh  
(Date)

: 22 NOVEMBER 2007

## **PERMISSION TO USE**

In presenting this thesis in partial fulfillment of the requirement for a postgraduate degree from Universiti Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor, in their absence, by the Dean of the Faculty of Information Technology. It is understood that any copying, publication, or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis, requests for permission to copy or to make other use of material in this thesis, in whole or in part should be addressed to:

**Dean of Faculty of Information Technology**

**Universiti Utara Malaysia**

**06010 UUM Sintok**

**Kedah Darul Aman.**

## **ABSTRACT**

The World Wide Web not only essentially changes the way and improves many things, it also greatly changes how computer software is built. Which profound evolution of software development has caused many in the software industry to change their way of developing software. In this project, Laboratory Information Management System (LIMS) for Faculty of Information Technology (FIT) has designed and developed using Throwaway Prototyping methodology with web architecture. Therefore, the software complies with Internet Technology Communication standards and uses an industry standard relational database management system (RDBMS) combined with a platform-independent web browser interface for data entry and retrieval (the 3-tier technology). The resulting system guides the users in the Faculty of Information Technology laboratory workflow steps facilitating the management and tracking of all electric devices, which ensures that the right information in the right form is available to the right person at the right time. System will result in faster work, fewer errors, and smoother workflow for an organization.

## ACKNOWLEDGMENTS

I would like to express my thanks and my gratitude to Allah, the most Beneficent, the most Merciful whom granted me the ability and willing to start and complete this project. I pray to this greatness to inspire and to enable me to continue the work for the benefits of my country.

I am deeply indebted to my supervisor Puan Juliana Wahid for her generous guidance and advice throughout this project. Her ideas, suggestions and constructive comments were very precious to me. My special thanks go to my evaluator for his helpful comments and suggestions.

Last but not the least; I would like to give my special thanks to my family for their fulfilling support and understanding as well as their prayers.

## TABLE OF THE CONTENTS

PERMISSION TO USE	i
ABSTRACT	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF FIGURES	viii
LIST OF TABLES	ix
LIST OF ABBREVIATIONS	x

### CHAPTER 1 INTRODUCTION

1.0 Background	1
1.1 Motivation	3
1.2 Problem Statement	4
1.3 Research Objectives	5
1.4 Scope of Research	6
1.5 Significant of Research	6
1.6 Organization of the Thesis	6
1.7 Summary of the chapter	7

### CHAPTER 2 LITERATURE REVIEW

2.0 Introduction	9
2.1 Concept and Definition: Information Management Systems (IMS)	10
2.2 History of LIMS	11
2.2.1 Pre-1982	11
2.2.2 The year 1982-87	11
2.2.3 The year 1988-90	12
2.2.4 The year 1991-95	12

2.3	Related works	12
2.3.1	LIMS for an Academic Microchip Fabrication Facility	12
2.3.2	Labrat LIMS: Micro Array Extensible Framework	13
2.4	Web Application Architecture	13
2.4.1	Presentation-oriented	14
2.4.2	Service-oriented	14
2.5	Web Application the 3-Tier Architecture	14
2.5.1	Web Caching	15
2.5.2	Web Browser	16
2.5.3	Web Server	16
2.5.4	Database System	17
2.5.4.1	Flat model	18
2.5.4.2	Hierarchical model	18
2.5.4.3	Relational model	18
2.6	Related technologies in web application	19
2.6.1	HyperText Markup Language (HTML)	20
2.6.2	Universal Resource Identifier (URI)	20
2.6.3	HyperText Transfer Protocol (HTTP)	20
2.6.4	Protocols	21
2.7	Related technologies	21
2.8	The advantage of web-based application	22
2.9	Summary of the chapter	23

### **CHAPTER 3 RESEARCH METHODOLOGY**

3.0	Introduction	24
3.1	Throwaway Prototyping	24
3.1.1	System planning phase	27
3.1.2	Requirements analysis phase	27
3.1.3	Brainstorm session	28
3.1.4	Develop paper prototype	28
3.1.5	Develop the web application prototype	29
3.1.6	Feedback using Usability testing	29
3.2	Summary of the chapter	32

## CHAPTER 4 ANALYSIS DESIGN AND PROTOTYPE DEVELOPMENT

4.0	Introduction	33
4.1	Analysis of function and design	33
4.1.1	Unified Modeling Language (UML)	33
4.1.2	Rational Rose Case Tool	34
4.1.3	Use Case Tools	35
4.1.4	Use case diagram of LIMS	36
4.1.5	Login system	38
4.1.6	Add System Configuration	40
4.1.7	Delete Computer Configuration	43
4.1.8	Edit/update System Configuration	46
4.1.9	Search Computer	49
4.1.10	View Report	51
4.1.11	Class Diagram	54
4.2	Tools used to design web pages	55
4.2.1	Scripting language	55
4.2.2	MySQL	56
4.2.3	Adobe Photoshop	56
4.2.4	Macromedia Flash	57
4.3	Guidelines in designing a web page	57
4.4	Development of LIMS prototype	58
4.4.1	Login Page	58
4.4.2	Home page	59
4.4.3	Registration (Add) New Devices	59
4.4.4	Update Device Lists	60
4.4.5	Delete Devices	60
4.4.6	Search	61
4.4.5	View Report	62
4.5	Summary of the Chapter	62

## CHAPTER 5      USABILITY TESTING

5.0	Introduction	63
5.1	Evaluation Techniques	64
	5.1.1 User Involvement	65
5.2	Usability Testing Results	65
	5.2.1 Convenience of the system	66
	5.2.2 Excellence of the content	66
5.3	Features of the system	66
5.4	Summary of the chapter	67

## CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6.0	Introduction	68
6.1	Conclusion	69
6.2	Problem and Limitations	69
6.3	Future Work	70

## REFERENCES

APPENDIX A : LIMS Login System	76
APPENDIX B : Add New Devices	78
APPENDIX C : Update Device/ System	82
APPENDIX D : Delete Devices	86
APPENDIX E : Search Devices	89
APPENDIX F : View Report	93
APPENDIX G : Computer System Usability Questionnaire	97
APPENDIX H : Perceived Usefulness and Ease of Use	99
APPENDIX I : Questionnaire for user interface satisfaction	101

## LIST OF FIGURES

Figure 2.1:	Overall Literature Review Discussion	9
Figure 2.2:	The 3-tier Architecture	15
Figure 2.3:	Web caching/ proxy server's request and responds	16
Figure 2.4:	HTTP protocols respond and request	21
Figure 3.1:	The main steps of throwaways prototyping methodology	26
Figure 4.1:	Use case diagram for LIMS	37
Figure 4.2:	Use case for login	38
Figure 4.3:	Sequence Diagram for Login	39
Figure 4.4:	Use case for Add System Configuration	40
Figure 4.5:	Sequence Diagram for Add System Configuration	42
Figure 4.6:	Use case for Delete System Configuration	43
Figure 4.7:	Sequence Diagram for delete System Configuration	45
Figure 4.8:	Use case for edit/update System Configuration	46
Figure 4.9:	Sequence Diagram for Edit System Configuration	48
Figure 4.10:	Use case for Search Computer/ Lab	49
Figure 4.11:	Sequence diagram for Search Computer/ Lab	50
Figure 4.12:	Use case for View Report	51
Figure 4.13:	Sequence Diagram for View Report	53
Figure 4.14:	Class diagram for LIMS	55
Figure 4.15:	LIMS Login system	58
Figure 4.16:	Display device lists	59
Figure 4.17:	Add New Devices	60
Figure 4.18:	Update Device/ System	60
Figure 4.19:	Delete Devices	61
Figure 4.20:	Search Devices	61
Figure 4.21:	View Report	62

## LIST OF TABLES

Table 4.1: Use case diagram notation	36
Table 5.1: Usability testing result	66

## **LIST OF ABBREVIATIONS**

LIMS	Laboratory Information Management System
FIT	Faculty of Information Technology
ELN	Electronic Lab Notebook
PC	Personal Computer
ICT	Information and Communication Technology
LAN	Local Area Network
IMS	Information Management System
RDB	Relational Database
SQL	Sequential Query Language
WWW	World Wide Web
HTTP	HyperText Terminal Protocol
HTML	HyperText Markup Language
FTP	File Transfer Protocol
ASP	Active Server Page
PHP	HyperText Preprocessor
TCP	Transmission Control Protocol
IE	Internet Explorer
CGI	Common Gateway Interface
URI	Universal Resource Identifier
URN	Universal Resource Name
URL	Universal Resource Locator
WYSIWYG	What You See What You Get
CMS	Content Management System
OS	Operating System
DBMS	Database Management System
UML	Unified Modeling Language
OOSAD	Object-Oriented System Analysis Design
VB	Visual Basic Programming Language
ID	Identification

## CHAPTER 1

### INTRODUCTION

#### 1.0 **Background**

Automation in the laboratory has created a demand for similar automation of information management with faster turnaround of data and increased access to information resources. Within the past decade, implementation of new, computerized information management systems designed to meet these needs has forced laboratories to confront the challenge of changing the way they do business. However, few issues can create the same level of turmoil as implementing a new LIMS (George et al., 2000).

Hinton (1995) the fundamentals of a LIMS. It establishes the criteria and goals of a LIMS as they pertain to a quality assurance laboratory. It may also be used as a reference in the design and implementation of a LIMS. The interest in LIMS is increasing; LIMS is a new field and encompasses multi-disciplines. A communication gap has existed between lab personnel and software users. It is hoped that this project will enable these disciplines solve the some problem. Lab personnel must have the ability to describe the necessary LIMS requirements in terms that can be understood by a software developer. Likewise, the software developer needs to

The contents of  
the thesis is for  
internal user  
only

chance and training that will enable staff to be more skillful. Skills that match new opportunities will enhance productivity and promote future brains that the labs will needs specification for a production-quality system.

As a conclusion, the proposed prototype system is a viable solution to be implemented by LIMS for developing web-based application. The research has not yet explored other web-based gadget with HTTP browser, thus making it a comprehensive proposal. Experimentation and evaluation of the prototype using real connection cannot be done due to limited financial budget.

LIMS web based application has the following features that will benefit the users:

Provides direct, simple access to the focused valuable content via few keystrokes or text entry only. Information regarding LIMS is trimmed page to page navigation down to a minimum and hyperlink buttons are used to navigate back. Reduces the amount of vertical scrolling by simplifying the text to display.

Finally, LIMS as a meaningful application turns the conventional information retrieval into simplest web based approach. User can utilize this application via client/server network or internet. The development of LIMS prototype indicates the change of application development. This will lead to extensive improvement of LIMS application that positively impacts the future technology.

## 8.0 REFERENCES

Antelman & mendizon (1998). *Design dynamic webpages*. New York : Winston.

Bodoff, S. (2007). *Introduction to Web Applications*, retrieved 9/7/2007 from <http://java.sun.com/j2ee/1.3/docs/tutorial/doc/WebApp.html>

Bryson, M. & de Castell, S. (1996). Learning to make a difference. *Gender, new technologies, and in/equity. Mind, Culture and Activity*, 2(1), 3-21.

Baumgartner, J. (2001), *The Complete Guide to Managing Traditional Brainstorming Events*. New Zealand: McGraw Hill.

Choo, C. W., Detlor, B. and Turnbull, D. (2000). *Web Work: Information Seeking and Knowledge Work on the World Wide Web*. Dordrecht, NL: Kluwer Academic Publishers.

Chiai Kim Heok, s. e. h. & Teo Kah Choo (2004). Database system. Singapore: Prentice Hall.

Clary B, Netscape Communications (2001). *Introduction to Web Applications, Some thoughts on Web Application Development*. Retrieved 8/7/2007 from <http://devedge-temp.mozilla.org/viewsource/2001/web-applications/>

Davis, F. D. (1989). *Perceived Usefulness, Perceived Ease of Use and End-User Acceptance of Information technology*. London: Prentice Hall.

Dan Bentley (1999). *Analysis of a Laboratory Information Management System (LIMS)*. Retrieved 30/7/2007 from [http://www.umsl.edu/~sauter/analysis/LIMS\\_example.html](http://www.umsl.edu/~sauter/analysis/LIMS_example.html)

Degan, A. D. (2004). *Web-based Application Development for Small Business*, Technical White Paper Version 1.2. California: McGraw Hill.

Elliott, M. H. (2003). *Considerations for Management of Laboratory Data Scientific Computing & Instrumentation LIMS Guide*. UK: McGraw Hill.

Ghezzi, E. A, Robert, N., Wilson, H. B. (1991). *Fundamentals of Software Engineering*. New Zealand: Prentice-Hall.

George. (2000). *Implementing LIMS: A "How-To" Guide*. Retrieved on 10/7/2007 from <http://pubs.acs.org/hotartcl>

Hendry (1990). *Database design and information system*. Texas: A&M University

Hilton, M. D. (1995). *Fundamental of a LIMS*. California: Osborne McGraw Hill.

Holcomb, R & Tharp, A. (1991). "Users, a software usability model and product evaluation", *Interacting with computers*, Butterworth-Heinemann, Oxford, UK, Vol 3(2) pp. 155-166.

Hoffer, J. A., George, J. F & Valacich, J. S. (1999). *Modern Systems Analysis and Design* (2nd Edition). United Kingdom: Addison Wesley Longman.

Ibm.com. (2007). *Paper Prototype*. Retrieved 25/7/2007 from <http://www.ibm.com>

Jeffrey, B. (2001), *The Complete Guide to Managing Traditional Brainstorming Events*. New Zealand: McGraw Hill.

Kerner, S. M (2006). *Is PHP The Cure For The 'Broken' Web?*, [internetnews.com](http://internetnews.com), 13 September 2006.

Koprowski. (2002) and steinlechner (2001). *Design LIMS with microarray*. Texas: A&M University.

Kothari, C.R. (1985). *Research Methodology, Methods and Techniques*. Delhi: Wiley Eastern Limited.

Liberty, J. (1998). *Beginning Object-Oriented Analysis and Design*. Birmingham: Wrox Press Ltd.

Moreover, D. (1999). *Advantages of Web-Based Application Development*. New York: ACM Press.

Navathe, E. A. (2007). *Fundamentals of Database Systems: Data Modeling Using the Entity-Relationship (ER) Data Model*. New York: Prentice Hall.

Nielsen, J. (1994). *Scenarios in discount usability engineering*. Envisioning work and Technology. Book under preparation.

Nielsen, J. & Landauer, T. (1993). *A mathematical model of the finding of usability problems*. In ACM INTERCHI'93. Amsterdam, The Netherlands, April. 206-213.

Pacslabs.com. *Laboratory Information Management Systems*. Retrieved 10/7/2007 from <http://www.pacslabs.com>

Patric, L. (2004). *A Guidelines to Design a Web Page*. Canada: Wrox Press.

Ramsay, M. & Johnson, G (1989). *Evaluating usability of human computer interfaces: a practical method*, Ellis Horwood Ltd, Chichester, UK.

Robert, A. G., Risen, D. A & Rose, C. W. (1977). *ACM SIGDA*. Newsletter 7 (1). New York: ACM Press.

Robert, W. H. (2000). *Distributed Computer Network and Microsoft SQL 2000 Server*. London: Prentice Hall.

Raymond, M. J. (1995). *Management Information System A Study of Computer-based Information System*. Texas: A&M University.

Reiven. (2007). *Advantages Importance and Implementation Plug-Ins*. California: Osborne McGraw Hill.

Rubin, J. (1994). *Handbook of usability testing: how to plan, design and conduct effective tests*. Jhon Wiley & Sons.

Schmitt. (2006). *Engaging a Rich Web Experience*. Greenwich: Manning Publications Co.

Shneiderman, B. (1998). *Designing the User Interface: Strategies for Effective Human- computer Interaction* (3rd ed). MA: Addison Wesley.

Shawn, M. (2007). *Paper Prototyping*. Retrieved 25/7/2007 from <http://www.alistapart.com/articles/paperprototyping>

Speelman. (2002). *Database Independent Implementation and Programming Language*. New York: Prentice Hall.

Steele, T. W., Laugier, A. & Falco, F. (1999). *The impact of LIMS design and functionality on laboratory quality achievements*. Brazil: ACM Press.

Usabilitybok.org. Methods: Rapid Prototype. Retrieved 25/7/2007 from <http://www.usabilitybok.org/methods/p312?section=how-to>

Ullman, L. (2003). *PHP and MySQL for Dynamic Web Sites* (1st Edition). London: Peachpit Press.

Vu Thi Thanh Huong (2006) *Policy and Measures to Promote ICT Application and Deployment for Business Development in Rural Areas in Vietnam*. (Project Proposal).

Valacich, J. S., George, J. M. & Hoffer, J. A. (2004). *Essential of system analysis and design*, Prentice Hall, Upper Saddle River, NJ.

Wood, L. (Ed.). (1998). *User Interface Design*. Boca Raton, FL: CRC Press.

**Interview**

Amran Bin Abdullah. System Analyst. FIT, Universiti Utara Malaysia. September 3, 2007.