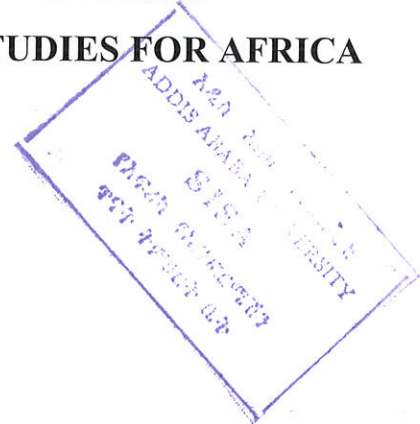


**ADDIS ABABA UNIVERSITY**  
**SCHOOL OF GRADUATE STUDIES**  
**SCHOOL OF INFORMATION STUDIES FOR AFRICA**



**DESIGN AND DEVELOPMENT OF A DATABASE ACCESSIBLE VIA  
THE WORLD WIDE WEB (WWW): THE CASE OF NATIONAL  
HERBARIUM OF ETHIOPIA**

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR  
THE DEGREE OF MASTER OF SCIENCE IN INFORMATION SCIENCE

**BY**  
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## ABSTRACT

*The proper organization of information has been proved important to render effective services for users. Lack of well organized information system creates several problems on the users of the system as well as the collection. As a major part of the collection of National Herbarium of Ethiopia (NHE), specimens are preserved at the herbarium to give services for the interested researchers and students. The existing information service at the NHE threatens the existence of specimen for a longer period, besides it is not possible to render prompt reply for users queries. Above all, though the users of the center are found in different part of the country, the center has no means of reaching them.*

*It was to alleviate the above mentioned problems that this study was undertaken. In the course, attempts have been made to assess user requirements by conducting extensive interview and observation. The survey revealed that the current information provision is inadequate. The existing system was analyzed and based on the user requirement obtained from the analysis of existing system a database was designed. Object oriented methodology was used in the analysis of the existing system as well as in the design of the proposed system.*

*Finally, a prototype of a web-based database was developed for selected class. The database was developed using Microsoft Access and Cold Fusion. The prototype was demonstrated for the users of the center and feedback was collected from users. Accordingly the prototype was modified. It is also recommended that the center needs to have a server to test the proposed database solution. However, the center can also make use of the proposed database by including some of the classes by upgrading the available LAN so that it could support web-based applications.*

## TABLE OF CONTENTS

<b>DECLARATION .....</b>	<b>I</b>
<b>DEDICATION .....</b>	<b>II</b>
<b>ACKNOWLEDGMENTS.....</b>	<b>III</b>
<b>ABSTRACT.....</b>	<b>IV</b>
<b>LIST OF FIGURES.....</b>	<b>V</b>
<b>LIST OF ABBREVIATION .....</b>	<b>IX</b>
<b>CHAPTER I.....</b>	<b>1</b>
1. INTRODUCTION.....	1
1.1 BACKGROUND OF THE STUDY .....	1
1.2. STATEMENT OF THE PROBLEM.....	4
1.3. JUSTIFICATION OF THE STUDY .....	5
1.4. OBJECTIVES .....	8
1.4.1 GENERAL OBJECTIVE .....	8
1.4.2 SPECIFIC OBJECTIVES.....	8
1.5. SCOPE AND LIMITATION OF THE STUDY .....	9
1.5.1 SCOPE.....	9
1.5.2. LIMITATION OF THE STUDY .....	9
1.6. METHODOLOGY.....	10
1.6.1. Data Collection .....	10
1.6.2. Analysis, design and testing.....	11
1.7. ORGANIZATION OF THE THESIS .....	11
<b>CHAPTER II.....</b>	<b>12</b>
HERBARIUM .....	12
2.1. Historical background and definition.....	12
2.2. The purposes of herbaria.....	13
2.3 Types of herbarium .....	14
General (international) Herbaria .....	14
National or (regional) Herbaria.....	14

Local Herbaria .....	15
.Special Herbaria.....	15
Historical herbaria.....	15
Herbaria of limited scope.....	16
Teaching herbaria .....	16
Job-related herbaria.....	16
Herbaria for special research programmes .....	17
2.4. Herbarium functions.....	17
2.5 Herbarium users and their information needs .....	18
2.6. Practices in herbarium automation.....	19
2.7 Herbarium databases .....	19
2.8. Trends in herbarium information systems.....	20
2.9. Trends in WWW based herbarium information systems .....	21
<b>CHAPTER THREE.....</b>	<b>23</b>
THE EXISTING INFORMATION SYSTEM AT NATIONAL HERBARIUM OF ETHIOPIA .....	23
3.1 Analysis of the Existing System .....	23
3.2 Historical Background .....	23
3.3.Collection Types and Size.....	25
3.4 Functions and Services.....	26
3.4.1 Acquisitions .....	26
3.4.2 Documentation.....	26
3.5. Services .....	27
3.6 Publications .....	28
3.7 Human Resources of the National herbarium of Ethiopia .....	28
3.8 Budget of the National Herbarium of Ethiopia .....	29
3.9 Computing facilities at the National Herbarium of Ethiopia .....	29
3.10. Users attitude about the current services of the National Herbarium of Ethiopia .	30
3.11. survey findings .....	31
3.12. Summary of Problems and Requirements.....	32
<b>CHAPTER FOUR.....</b>	<b>34</b>
DESIGN OF THE PROPOSED SYSTEM.....	34
4.1. System Requirement .....	34
4.1.1. Collection related.....	34

4.1.2. Search facility .....	35
4.1.3. General requirements .....	35
4.2. General Design Considerations .....	37
4.2.2. Object orientation .....	39
4.2.2.1. Object orientation (basic concepts).....	39
4.3. The Design of National Herbarium of Ethiopia Database .....	42
4.4. Use cases of National Herbarium of Ethiopia Database (NHEDB).....	44
<b>CHAPTER V .....</b>	<b>62</b>
<b>PROTOTYPE DESIGN .....</b>	<b>62</b>
5.1. INTRODUCTION.....	62
<b>CHAPTER VI .....</b>	<b>70</b>
6.1. CONCLUSION AND RECOMMENDATION .....	71
6.1.1. CONCLUSION.....	71
6.1.2. RECOMMENDATIONS.....	72
<b>BIBLIOGRAPHY .....</b>	<b>74</b>
<b>APPENDIX.....</b>	<b>1</b>

## LIST OF FIGURES

<b>Fig 3.1. Organizational Structure of the NHE .....</b>	<b>25</b>
<b>Fig 4.1. Use cases .....</b>	<b>45</b>
<b>Fig.4.2. Collaboration diagrams .....</b>	<b>47</b>
<b>Fig.4.3. National Herbarium of Ethiopia subsystems.....</b>	<b>49</b>
<b>Fig.4.4.. NHEDB contracts .....</b>	<b>49</b>
<b>Fig 5.1. Welcoming screen.....</b>	<b>64</b>
<b>Fig. 5.2 Information screen .....</b>	<b>65</b>
<b>Fig. 5.3. List of specimens screen.....</b>	<b>66</b>
<b>Fig. 5.4. Edit screen.....</b>	<b>67</b>
<b>Fig. 5.5. Add screen.....</b>	<b>68</b>
<b>Fig. 5.6. Search screen .....</b>	<b>69</b>
<b>Fig. 5.7. Image screen .....</b>	<b>70</b>

## **List of Abbreviation**

API	Application Program Interface
ISAM	Indexed sequential Access Method
CGI	Common Gateway Interface
HTTP	Hypertext Transfer Protocol
NCSA	National Center for Supercomputing Application
NHE	National Herbarium of Ethiopia
NHEDB	National Herbarium of Ethiopia Database
EFP	Ethiopian Flora Project
WWW	World Wide Web
SAREC	Swedish Agency for Research Cooperation with Developing Countries

# CHAPTER I

## 1. INTRODUCTION

### 1.1 BACKGROUND OF THE STUDY

The impact of information on development has been and is being felt and seen in our day to day life. Specially scientific and technical information have given human being competitive edge in the development process as the advantage accrued in having scientific and technical information is enormous. As Atherton ( 1977) notes the benefits of large availability of scientific and technical information leads to :

- improved capability of a country to take advantage of existing knowledge and "know-how" achieved elsewhere.
- Rationalization and systematization of a countries research and development efforts in light of knowledge already available.
- Wider knowledge base for the solution of problems.
- New alternatives and approaches to the solution of problems
- New alternatives and approaches to the solution of technical problems, and options for minimizing future ones.
- Improved effectiveness and efficiency of technical activities in the production and service sectors.
- Above all better decision-making in all sectors and at all levels of responsibility.

To be benefited from these advantages depends on the amount of attention that is given by specific country on the development of scientific and technical information system. However, developing countries fail to integrate scientific and technical information in the development process. According to Atherton(1977):

"most nations have extremely limited capabilities and resources, both human and financial, to devote to the production and acquisition of scientific and technical information. Many of the developing countries produce less than one percent of the world's scientific literature and perhaps an even smaller portion of the total technical information. Some very advanced countries produce little

more than 5% of scientific literature. These facts are relevant only in demonstrating that a country's development depends on its application of knowledge and information rather than in the generation of new knowledge. The knowledge and information are readily available somewhere in the world; they must however be made accessible to all kinds of decision-makers, to entrepreneurs and scientists, engineers and technologists, and means for communication and transfer must be established. In fact, in many countries it is the gap in information accessibility and transfer, and therefore of use, which must be bridged if economic progress to be made."

The meager percentage of contribution to the scientific literature can be attributed to lack of scientific and technical information systems that effectively organize scientific and technical data. The handling of scientific and technical data may include the generation and presentation of data, the collection and evaluation of data, standard units, symbols, and nomenclature of data, facets for describing data.

As a result, time spent in searching for information by professionals in developing countries is tremendous. It is usually recognized that highly educated professionals spend around 20% of their time looking for information. Approximately twenty developing countries each have over 100,000 such professionals. The total time spent by 100,000 professionals searching for information is approximately 50 million hours per year (Atherton, 1977).

The preliminary investigation made by the researcher also proved that most of the above problems hold true with the National Herbarium of Ethiopia. The system now is suffering from:

- Time delay in providing information for users specially in generating report from the manual system
- Mobility of specimens that leads to the decline in the quality and decrease in the life span of the specimen in the center

- Indexing technique that is not exhaustive thus only partial information about specimen can be retrieved.
- Lack of detailed information concerning the number of species, genus and family.
- Exhibiting the available Ethiopian flora to distant located organizations and researchers.

These have contributed negatively to the operation of the system and to the development of the national scientific and technical information at large. Indigenous development requires more than the creation of stocks of information. It requires the use of information by people. However, no organizational pattern or fixed solutions can be prescribed to meet this requirement in light of the variety of needs and the socio-economic conditions. There are wide ranges of approaches to improved use of information. Some of these solutions are summarized by Saracevic and Wood (1981):

- more involvement of information systems with user demand; studying the users more closely; evaluating services/products in terms of their use.
- Tailoring the variety of information services/products to the variety of user levels and demands.
- Organizing mechanisms for more effective information delivery to problem solvers, employing information technology and networks appropriate to their circumstances.

Realizing the negative impacts of the aforementioned problems on its information system, National Herbarium of Ethiopia has included the development of a specimen database in its future plan. However, the kind of database needed, what users are expecting from the system and the type of technology to be used are not taken into consideration. The approaches summarized by Saracevic and Wood (1981) and those by the National Herbarium of Ethiopia

can be realized when a system is well organized and renders services that take users' needs into account. One such system is the proposed information and database system that gives more emphasis to the information requirements of the potential users.

## **1.2. STATEMENT OF THE PROBLEM**

The research questions that this study addresses include:

- Is the development of database the right solution for the existing problem at the National Herbarium of Ethiopia?
- Who are going to use the database?
- What are the major information requirements of the user?
- What kind of database is needed to solve the problem at hand?, how such database is going to be developed?

In addressing these fundamental questions the research made evaluation on the needs of users, current system and proposes a web-based solution.

### 1.3. JUSTIFICATION OF THE STUDY

A database that organizes the records effectively and efficiently can alleviate the problems of information retrieval. A database in technical terms, is a structured store of data; that is, a store containing both data and the means of maintaining relationships between the real entities-physical objects, events and abstract concepts-described by the data. Where as database in application terms, a data file or set of data files designed to reflect the nature of the data they hold rather than the needs of particular applications that process them. This has great advantage that a set of integrated files can be created to serve a number of related applications. This reduces inconsistencies and eliminates the need to transfer information between them (Gunton, 1993).

A database service is one of the services provided by a computer-based information system. A computerized system can also facilitate activities like statistics, preservation, and status of specimen. For example, the following statistical concerns could be programmed into the system: the frequency of "use" of specimen, the relative cost of upkeep for any group or type of item, etc. Preservation schedule could also be put online to assure its completion on time (example, time line and requirement for maintenance). Status issues might include priorities for exchange and policies for loan, exhibition, and research (Moline, 1991).

A database system as a computer-based information system can make all the records available in a digital format. The reasons to digitize collections include:

- Conservation: converting the collections of such kind of systems into high quality digital images allows one to avoid accessing the originals thereafter.

- Manageability: if the system is networked or the size of the database is manageable to be copied into a disk, processing such collections in an environment where tools for image enhancement are available provides much better access to the individual specimen than would be possible on a standard desk in the user room of the center.
- Accessibility: storing the specimens in a central database system allows to provide a copy "instantly" on the screen, without long waiting periods until the original is retrieved from a physical repository.
- Reproducibility: the content of a specimen together with its picture can be reproduced from the database to avoid the physical damage of original as the movement of each individual specimen does.
- Searchability: attaching a machine description to the specimen enable the users to look for materials much more quickly than by means of traditional index or catalogs.
- Besides, having information about all the collections in the database can also alleviate the burden that is imposed on the editors. Anyone who has access to the database can simply search and print whatever information he/she needs before the editor is finished the editing process (Thaller ,1995).

Likewise, the National Herbarium of Ethiopia can benefit from all the above advantage that a digitized information system renders. In the center, besides the specimens, plants are photographed and kept with descriptions such as scientific name, name of the collector, the

date when the specimen is collected, the geographical area the specimen found, etc. These data can be organized and kept in a database to efficiently serve the users of the center.

In addition, developing a database and making it accessible through the World Wide Web can be of great help to institutions that make research on plants and teach biology courses in different part of the country. It would also cut the cost of printing and buying books since the information would be available online from the National Herbarium of Ethiopia. Besides, the database can be used to disseminate indigenous knowledge on plant that is available in some part of the country to the other part of the country and to the international community at large. It would also help as a means of communication on endemic plants of Ethiopia globally. Generally a database would enable researchers all over the world to get information about Ethiopian flora easily.

The research thus intends to address the question of implementing a database at National Herbarium of Ethiopia and possibilities to dissemination of the holdings of the herbarium online via the World Wide Web (WWW).

## **1.4. OBJECTIVES**

### **1.4.1 GENERAL OBJECTIVE**

The general objective of this study is to assess the information requirement of users with a view of designing and developing a web accessible database at the National Herbarium of Ethiopia. It includes analysis of the existing system in order to identify the problems of the existing system there by to define user information requirement in order to come up with the system that meets the users needs.

### **1.4.2 SPECIFIC OBJECTIVES**

In order to achieve the general objective, the study aims at

1. Assessing the information requirement of the users of National Herbarium of Ethiopia.
2. Identify the existing problem of the system.
3. Define the information requirement of the user and propose new system that meets the identified user needs. This include:
  - determining the database structure and the attributes to be included
  - designing a search interface that facilitate retrieval of information from the database.
4. Developing a prototype of the proposed system in order to demonstrate the potentials of the proposed system.

## **1.5. SCOPE AND LIMITATION OF THE STUDY**

### **1.5.1 SCOPE**

The study covered those information activities of the National Herbarium of Ethiopia pertinent to the handling of specimen.

### **1.5.2. LIMITATION OF THE STUDY**

Due to limitation of time the prototype was developed for selected subclasses of a transaction class and it is tested and feedback is collected from selected part of the user community.

Since the only service provider in the country is Ethiopian Telecommunication Authority (ETC) and it does not provide server for dynamic web pages, it was not possible to test the prototype on actual network environment.

Again due to time limitation the software and hardware considerations for the proposed system were not included.

## **1.6. METHODOLOGY**

The methods used in this research were a survey to users, an object-oriented analysis and design for designing the database and a relational database system and a web interface to implement the prototype.

The survey research methods employed in order to know the information requirements of the users of the National Herbarium of Ethiopia. Besides object oriented systems analysis and design approach was used while analyzing the existing system and designing the proposed system. The following tools were used in the course of the study:

### **1.6.1. Data Collection**

*Interview:* interview was conducted with those users that are believed more important and have rich experience in using the center. These personalities include those who are based in the center and doing research at the National Herbarium of Ethiopia and those who are managing the system. These include the technicians who are serving the users and maintaining the specimen records. Interview was also conducted with users that came from other institutions to carry out research at the herbarium.

*Document analysis:* documents that were pertinent to the study were consulted.

## II. Analysis, design and testing

*Object oriented systems analysis and design tools:* as these have become popular for shortening the steps in the systems development compared to the structured systems analysis and design tools, object oriented systems analysis and design tools were applied.

### *Applications used to develop the prototype*

Microsoft Access and Cold Fusion 3.1 were used to develop the prototype. Microsoft Access was used to design the database. Cold fusion was implemented to make a database accessible via the World Wide Web.

## **1.7. ORGANIZATION OF THE THESIS**

The thesis is organized into six chapters. The second chapter discusses the subject area on which the theme of the thesis dwelt upon. The third chapter is devoted to the analysis of the existing system. The fourth chapter describes the design of the proposed system based on the analysis and the survey results. The fifth chapter shows a prototype of selected subclasses of a class. Finally, the sixth chapter presents conclusion and recommendations made on the study.

## CHAPTER II

### HERBARIUM

#### 2.1. Historical background and definition

According to the Encyclopedia of Science and technology, herbarium is a collection of pressed and dried plant material arranged in systematic order that facilitates examination of all of the material of a particular group. It is a collection of preserved plants built up over a long period of time. It is a repository of information and a research tool of considerable value; it is a library of plants.

The word herbarium in its original sense referred to a book about medicinal plants. Luca Ghini, a professor of Botany at the University of Bologna, Italy, is thought to have been the first person to dry plants under pressure and mount them on paper to serve as a lasting record. This practice spread throughout Europe and the herbarium technique was well known. Many early herbaria were bound into book like volumes rather than being kept as separate sheet. At first herbaria were mostly privately owned, but the practice of depositing specimens in established collections and exchanging specimens or selling collections was a common practice (Bridson and Forman, 1989).

### **2.3 Types of herbarium**

Herbaria, based on their size of collections, the functions that they carry out and the spectrum of services that they render are categorized as general, national, special and local herbaria. The size of the herbarium and the type of work it undertakes will, to a large extent, dictate the methods of arrangement and curation needed to run it as an efficient machine (Bridson and Forman, 1989).

#### **General (international) Herbaria**

General (international) Herbaria, as the name implies, are very large herbaria that have 4 million or more specimens and with global representation of as near a comprehensive range of taxa as possible.

#### **National or (regional) Herbaria**

National or (regional) Herbaria are herbaria that geographically cover the country concerned and neighboring or phytographically similar areas. It is mandatory to represent all taxa relevant to the area as far as possible.

## **Local Herbaria**

Local herbaria deal with specific region within a country such as state, country or district or even a much smaller area such as game park or nature reserve. All taxa relevant to the area should be represented, but it is not necessary to keep large numbers of each taxon.

## **Special Herbaria**

Special herbaria are usually small and have limited scope or a specific purpose; there are several types of special herbaria depending on function:

### Historical herbaria

Historical herbaria are herbaria that may belong to a separate institution or are kept as separate herbaria within a general herbarium. Specimens in historical herbaria are arranged in their original sequence (not updated to current taxonomic opinion) and have restrictions governing consultation and loans. The more important historical herbaria have been put on microfiche to help overcome the problem of accessibility. This is because historical herbaria are rich in type specimens.

## Herbaria of limited scope

These herbaria may be limited in scope either taxonomically (e.g. cryptogamic herbaria) or ecologically (e.g. forest herbaria). Since they have considerable size of specimens and great importance, they should be considered with national herbaria. They often can be found separately housed within general herbaria or other institutions such as universities or museums.

## Teaching herbaria

*Teaching herbaria* are housed in universities, in college and schools. Teaching herbaria often contain specimens to illustrate morphological structures, the types of plants representative of communities encountered in field studies, examples of both economic species and species of locally grown crops, and a series of illustrate families and genera for taxonomic instruction.

## Job-related herbaria

Job-related herbaria could include collections that are related to specific jobs. For example, weed species for agriculturists or honeybee plants for beekeepers. They should contain good examples of all relevant taxa but multiple collections of the taxon are not desirable.

## 2.5 Herbarium users and their information needs

Users are the beginning and the end of all information systems. That's why information service providers give much emphasis on analyzing the information needs of their users. Delivering information that can precisely satisfy users needs is the ultimate aim of any information service. Information needs and users are studied with a view to improve the overall system of information transfer. Obviously, the key to the success of information transfer depends largely on accurate identification of what the users need (Pao, 1988).

The users of an herbarium are limited in number. They are basically specialized type of users. These are technicians that serve the users, researchers hosted in different institutions and visitors that are interested in visiting herbariums. The information requirements of these users include:

***Collection management information:*** information on how specimens are preserved, dried and kept in the herbarium.

***Indexing information:*** information on how to identify the scientific name, collector, distribution etc., of a give specimen.

***Research and related information:*** information on the research that is being undertaken on a given species, for what purpose is the research being conducted and who is conducting.

***Publications:*** data on the available flora publications and those that are under consideration to publications.

*Statistical data:* statistical data that is usually kept in an herbarium covering transactions made on loans, exchange, visits, etc. such information is usually available in manual format. However, there is a growing move towards automation of herbarium information.

## **2.6. Practices in herbarium automation**

The botanists have long recognized the use of computers in the herbarium. Especially the development of databases for specimens in different herbaria is cited in different literatures (for example Bridson and Forman, 1989). The literature also mentions the purpose for which computers are applied in the herbaria. Among these, Crosby et al, 1988 as cited by Macrander and Haynes, 1990, notes that "... the major uses of computers by botanists are in the area of manuscript preparation and development of small specimen databases in support of monographic work."

As it can be inferred initially automation has been exercised in limited activities of the herbarium. However, it is increasingly been applied for different activities (for example loans, preparation of label, determination list, etc) of the herbarium as the benefits become more popular. There are various information services and databases for the herbaria throughout the world.

## **2.7 Herbarium databases**

The advent of databases represents a major innovation in the conduct of botanical, ecological, and conservation investigations. In general, the computerized availability of specimen data speeds access to large bodies of botanical information. The associated data management

systems frequently provide an array of managerial and information management capabilities. The benefits that are accrued in herbarium databases as outlined by Crosby et al, 1988, as cited by Macrander and Haynes, 1990 are:

1. Printing of labels for new and existing specimens;
2. Tracking of transaction (i.e., loans, exchanges, gifts, etc.); and
3. Alleviating the burdensome process for answering external data requests.

The implementation of various databases and the advent of networking have recently resulted in herbarium information systems worldwide.

## **2.8. Trends in herbarium information systems**

Herbarium information systems are set up to serve researchers and other specialized types of users that are interested in plant information. Herbarium information systems or centers are centers that house collections of specimens that are pertinent to their objectives. Manual handling of a number of specimens for information purpose makes retrieval of information related to the specimens difficult. In the process of information retrieval from a specimen, specimens can be damaged, misplaced, or lost while they are out for loan or exchange. Thus an herbarium information system (computerized) must be in place to overcome the limitation imposed by the manual system. Besides, the availability of specimen data in an electronic medium enables cross-referencing with other electronic data sets, such as soils, land-use, land-cover, and or geology. Ecologists will be able to compile botanical profiles for areas specified through political or locational descriptors (i.e., township-range-section or latitude). They will be able to identify species assemblage and to correlate species distribution with

environmental conditions. Conservationists will be able to quickly identify species for which collections are restricted or diminishing (Crosby et al, 1988, as cited by Macrander and Haynes, 1990). Networking has also created for information systems to make collections available to global users.

It is the above mentioned importance that are amass in the specimen and the capability of WWW and dynamic database tools created opportunities for direct researching of herbaria database from the WWW.

### **2.9. Trends in WWW based herbarium information systems**

The advent of Internet has created opportunities to established herbarium information systems to be available through the World Wide Web. Web technology provides an entry to the various information embodied in different web accessible databases. Connecting the herbarium databases via WWW makes various flora information available to unlimited number of users worldwide. There are a number of web accessible herbarium databases including:

1. SMASH (Specimen management Systems for California Herbaria )  
([http://ucjeps.herb.berkeley.edu/smash\\_dist/index.htm](http://ucjeps.herb.berkeley.edu/smash_dist/index.htm))
2. Harvard University Herbaria (<http://www.herbaria.edu/Data/types.readme2.htm>)
3. UCDAVIS HERBARIUM. (<http://herbarium.ucdavis.edu/herbaccess/databaseInfo.htm>)

Limited cost of networking tools and availability of easy to use software has made it easier to the herbaria in developing countries to get online. The research was intended to investigate

the feasibility of making the National Herbarium of Ethiopia online. Chapter three provides analysis of the existing system.

## **CHAPTER III**

### **The existing information system at National Herbarium of Ethiopia**

#### **3.1 Analysis of the Existing System**

This chapter provides analysis of current information system at National Herbarium of Ethiopia (NHE). Analysis of the existing system is made based on literature review; observation and extensive discussion conducted with the staff and researchers that work at the NHE and researchers that came from different institutions in the country. The discussion guide used in this study is attached in appendix I.

#### **3.2 Historical Background**

The history of National Herbarium of Ethiopia dates back to 1959. It was established with the collections made by Dr. H.F.Mooney from Great Britain. When Dr. Mooney left the herbarium in 1960, it had 6000 specimens. The National Herbarium of Ethiopia was founded in the formerly university college of Addis Ababa, now called Addis Ababa University. It was established from resources made available by the Royal Botanic Garden, Kew, England and the Ethiopian government. Currently, it is located at the Faculty of Science, Addis Ababa University, and is administered by the Biology Department.

There was limited effort to improve its collection for about 20 years. However, the Herbarium has been increasing its collection of plants since the initiation of the Ethiopian Flora Project (EFP) in 1980. This project was started with funds secured from the Swedish Agency for Research Cooperation with Developing Countries, (SAREC), and the Ethiopian Government.

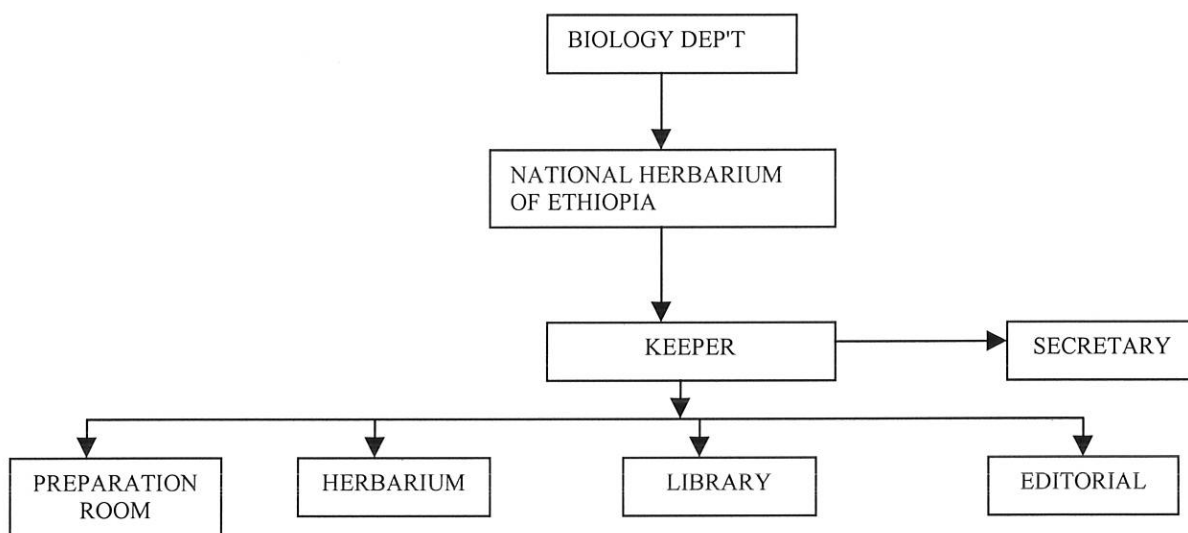
According to Tefera, 1994, The project was launched with three major objectives:

1. To write up an Ethiopian Flora within the shortest time possible;
2. To build up a national Herbarium and a related library to be used as reference centers for taxonomists, pharmacognosists, agriculturists, foresters, wildlife specialists, etc;
3. To promote scientific activities in taxonomic botany, economic botany, forestry, plant ecology, etc.

Having established with these major objectives, the Ethiopian Flora Project has contributed immensely to the development of the Herbarium. One of the major achievements of the Ethiopian Flora Project (EFP) was its contribution to increase in number of the collection to about 73000. It has also resulted in increasing the number of staff and expanding the organization.

The current organizational structure of NHE is shown below.

**Fig 3.1. Organizational structure of the NHE**



### 3.3. Collection Types and Size

The National Herbarium of Ethiopia's collections constitutes specimens mounted on paper, slides, and photographs of plants. Among these the institute has exact figure of the specimens only. Other types of collections are kept in the library as well as in the personal collection of the researchers that reside in the institute. Therefore the exact figure of these collection is not known. Obviously lack of an organized information system has contributed to scattered collection of especially the photographs and slides.

### **3.4 Functions and Services**

The functions of the NHE are similar to that of functions outlined in the second chapter section 2.4. Thus a brief account of the practices exercised in the center concerning functions and services are described as follow:

#### **3.4.1 Acquisitions**

The specimens in the NHE are acquired by donation, gift and exchange, or by collecting from different part of the country. Other herbaria donate or give specimen to the NHE. The NHE also exchanges specimen with different herbaria, (for example Kew in the UK). However, the majority of specimens are acquired by collecting specimens from different parts of the country.

#### **3.4.2 Documentation**

Documentation of activities that are being carried out (manually) in the NHE are of two types: collection management information - records associated with loan, exchange, treatment; and indexing records associated with indexing specimens. These major documentation activities are discussed below.

*Loan and exchange:* loan and exchange of specimen is recorded in the form prepared for this purpose. Loan and exchange made between the NHE and the requesting institutions for the specified period of time are clearly stated in the form.

*Maintenance (treatment):* in the NHE there are two kinds of treatment to preserve the specimens. The first is deep freezing where specimens are taken to the section where they are kept in deep freeze. When specimens are out for such treatment, information is written on a piece of paper and is kept in lieu of the specimen that is sent for treatment. The second kind of treatment is fumigation. The rooms that house the specimen are fumigated and closed for two or three days. This is usually done during weekends.

*Indexing:* when specimens first arrive in the National Herbarium of Ethiopia they are recorded in an index card. The index is arranged alphabetically by family. However, the index does not serve as a retrieval tool.

*Guide:* information describing the genus, cupboard, shelf number and remark of the genus is kept in a guide. The guide is meant for those specimens that are available in the published version of Ethiopian Flora. In addition to the functions described above, the National Herbarium of Ethiopia provides the following services:

### **3.5. Services**

The NHE provides the following services.

*Identification:* identification of plant name is the major service that is rendered by NHE. Users usually come up with sample plants that they are interested in. The scientific name of the sample plant is identified by the National Herbarium of Ethiopia. The National Herbarium of Ethiopia charges users five birr per specimen.

The following table lists the current Software available in National Herbarium of Ethiopia.

Packages	Version	Application
Ms Office	97	Fortran
Ms Office	98	
WP	5.1	
Excel	97	
Ventura	4.0	
dBase	5.0	
NovellNetware	3.1	

**Table 3.2. software available in the center**

The softwares available in NHE are used for the purposes of communication, editing and clerical office purposes.

The center has also Local Area Network based on Ethernet. There are ten computers that are connected to the network. The operating system used for the network is novel 3.1. The network has been in use for over a year, however users have not benefited a lot from it. The following section covers attitude towards overall service at the NHE.

### **3.10. Users attitude about the current services of the National Herbarium of Ethiopia**

The major users of NHE include academicians, students, researchers from abroad and local researchers from different institutions, government organizations, non-governmental organizations, associations and industries. The research has covered users from different institutions. The main user category for the survey was both students undergraduate and postgraduate and researchers working at NHE as well as researchers that came from other

institutions. Among these users all post graduate students that were doing research on the NHE were interviewed with few undergraduate students. Other researchers from different organizations were also interviewed while they were visiting the herbarium. The interview discussion guide is shown in appendix I.

### **3.11. Survey findings**

The summary of the interview results show that seventy seven percent of the users get information from printed flora as well as by searching the physical collection of the specimens.

Regarding the adequacy of current information provision, 81.8% indicated that it is inadequate and when asked on the solution to the current information provision, 63.6% of them mentioned family index as a solution, 68.2% genus index and 54.5% species index. There were also respondents that suggest database as a solution. Conversely, 14.5% of the respondents said the current provision of information is adequate. Their reason was that they often get whatever information they require.

Among users interviewed, 72.7% were found to be familiar with Internet and 40.9% of them were aware of herbarium information available on the World Wide Web. Of these 54.5% thought that it is important to make the herbarium collection accessible via web. When asked whether they think of any pitfalls in making herbarium data available on the web the majority were unable to mention any pitfalls. Finally, 72.3% of the respondents believed that the use of web accessible multimedia database in the NHE facilitate their access to the herbarium irrespective of their institution's location.

### 3.12. Summary of Problems and Requirements

The survey and analysis have also shown the following impediments that hindered the provision of information service at NHE.

- There is no uniform classification system used at the NHE. The classification systems that are in place are based on simple alphabetical order for non-published Flora. Hutchinson method of classification for the published flora.
- The index cards do not contain complete information and it serves for the purpose of inventory only. The index card describes only the total number of specimen available in NHE by family.
- Inventories are carried out only when a collector reports the disappearance of specimen that has been collected by himself. Hence it is not possible to identify the disappearance of specimen promptly.
- The existing documentation system doesn't facilitate the selection of specimen for treatment, identification and retrieval.
- Preparation of labels, guides, etc. is time consuming and tiresome.
- Users mishandle specimens which often lead to the deterioration of the quality thereby shortens the age of specimens.

## **CHAPTER IV**

### **DESIGN OF THE PROPOSED SYSTEM**

In this chapter, an integrated database system is proposed. Requirement of the proposed system in terms of data management and processing is outlined, followed by an approach for the design of the proposed database solution.

#### **4.1. System Requirement**

The survey and analysis identified the following systems requirements for the National Herbarium of Ethiopia.

##### **4.1.1. Collection related**

Collection related information include:

- Database that facilitates the maintenance of collection covering information for all media available at the herbarium. i.e., text about specimen, pictures of specimen, and slides of specimens;
- Database that facilitates the maintenance or conservation related information: this includes records of conservation and treatment efforts;
- Database that facilitates the maintenance of research information: bibliographic, profiles of institutions, and biographies.

#### **4.1.2. Search facility**

Search facilities required to access the database would include:

- Interactive database access;
- Access to full indexing information by family, genus, or species;
- Access to integrated information for a specific specimen specially photographs and texts;
- Access to other collections in other herbaria via WWW;
- Access from WWW to the herbarium collection

#### **4.1.3. General requirements**

In addition to access there is a need to conform to global standards. Some of the general requirements identified include:

- Adopting a format that complies with other herbaria.
- Setting up an Internet connection. Access to the Internet would facilitate: collaborative research, communication with similar institutions, information exchange about loan/exchange of specimens, tracing lost specimen, advertising the available indigenous knowledge on plants to local and foreign research community.

#### ***4.1.4. Process related requirement***

Collection of plant specimens is carried out as per the convenience of the herbarium and the season that is most conducive to collect plant specimens. The process of collection is initiated either by the herbarium or by those who are interested to undertake research on some plants. When these researchers initiate the process, specimens that they are interested in are checked out for the fieldwork by technicians. The technicians in the field are assistants to the researchers in collecting specimens. The specimens that are collected by the researchers become part of the herbarium collection. While plant specimens are collected in the field, the necessary data like collector number, locality, region, description (unseen characteristics of the plant after it is dried like tree hurb, climber and shrub; flower color, etc.) and elevation are all recorded in a notebook of the collector. The plants that are collected are kept lying flat to view upper and lower surface of leaves including flower and fruits. Then the plants are pressed between newspaper on which the collector number will be written. On the top and bottom of the newspaper there will be blotter and card border (ventilator), wooden frame and strap to tie the pressed specimen properly.

The collected specimens are then dried by the sun or by using gas cylinder while in the field trip and or using an electric drying cabinet in the office. Then the dried specimens are arranged sequentially by collector number. The labels for the specimens are prepared using word processing software. Labels are then inserted on each dried plant specimen and will be ready for mounting. After the mounting process, the specimens are registered in the record book of the herbarium (collector name and number) and then sent for freezing for about 48 hours so as to kill insects that arrive together with the specimen.

After all these procedures specimens become part of the herbarium collection. Before specimens are kept in the cupboard, they are alphabetically arranged. This helps to combine similar species together and to prepare an index card. Stamping and issuing specimen number is carried out before the herbarium specimen is incorporated in the cabinet according to their family.

## **4.2. General Design Considerations**

As it can be inferred from the requirements outlined above, the objective of the study is to develop a database that provides information about the available flora of Ethiopia in text as well as image format. The interactive multimedia is chosen as the appropriate tool to handle such information.

### **4.2.1. Choice of multimedia**

The underlying premise of this study is that since specimens kept in the herbarium have invaluable information about the available flora of Ethiopia they need to be preserved as much longer period as possible. However, the prevailing situation in the Herbarium threatens the existence of these specimens for a long period of time. As it has been gathered from the survey and personal observation, the behavior of the users in the course of using specimens showed that users do not give much attention as how to handle these specimens, so that they would have an over lasting life. On the one hand, if the available data is digitized and stored in a database, most of the users do not need to access the specimens physically. If the location of specimens were incorporated in the index the technicians in the center would not require to

use their guess as where to find the specimen that answers the users query. This would avoid dependency on the technicians to retrieve the available data in the center.

Moreover, with the advent of WWW making the herbarium collection web accessible would enable the center to provide services to remote users. The center would make a link to those herbaria that are web accessible and exchange information on equal basis.

As the WWW accommodates multimedia formats of information, the available flora of Ethiopia can be presented in the form of text and scanned picture of the specimens. The database can be searched using free text or picture of the specimen. Multimedia as outlined by Woinshet, 1997 would provide the following options:

a) Enhanced Integrated Multimedia database that would facilitate

- Creation of integrated information, covering the index and collection management information, other research related records such as bibliography, biographies, information on treatment procedures and technique etc.
- Publishing of compact discs of the NHE collection for wider dissemination.
- Creation of better interfaces: such as touch screen, map, etc. to students.

b) Intermediate multimedia database system that would facilitate:

- integration of more than one media including structured text, unstructured text, and image
- integration of different types of information including index and other collection management information such as treatment and movement

- Information retrieval using different characteristics of the specimen.
- Production of guides, labels, inventory list, etc.

The first option could support almost all the requirements of the system. Nonetheless, it may not be affordable by the NHE due to resource limitation. It is advisable for the center to consider intermediate multimedia database. This option could be used to overcome most of the problems reported in the existing system and may be implemented using the low cost technologies affordable by the NHE. Object oriented analysis has been used to identify the data sets to be covered by intermediate multimedia database system.

#### **4.2.2. Object orientation**

Systems development requires a good system analysis and design methodology. Object-oriented approach is followed in analysis and designing phases. Object-oriented methodology has become popular to map real world concept into a system. Besides, object-oriented technology is aligned with new technology trends, like event driven graphical user interfaces, multimedia systems(voice, image, animation), and highly parallel processing (such as those used in full text searching and retrieval )( Khoshafian, 1993). Object oriented methodology depends on the key concept of object and object characteristics such as message, encapsulation, class, inheritance and polymorphism.

##### **4.2.2.1. Object orientation (basic concepts)**

**Object:** According to Whitten & Bentley 1998, an object "is something that is capable of being seen, touched, or otherwise sensed. It is something about which users store data and associate behavior. Where behavior refers to those things that correspond to functions that act

on the objects data (or attributes)." The very feature of object that makes it significant in the object orientation approach is that it resembles more with the real world. Problems that are described in terms of objects are analogous with the way things are working with the natural environment. Objects have the following characteristics:

**a) Message:** Objects communicate through message. A message is passed when object invokes one or more of another object's methods (behaviors) to request information or some action.

**b) Encapsulation:** Encapsulation is information hiding. It is providing access to an object through its message while keeping the details inaccessible. It is the packaging of several items together into one unit, both objects' attributes and behavior of the object are packaged together (Whitten & Bentley, 1998; Coad & Nicole, 1993).

**c) Classes and instances:** Objects can be organized into classes. A class is a group of objects that share common attributes and behavior. Consider a class of objects called animals. If one animal can breath, eat, and reproduce, all animals can. And an object that belongs to a class of animal is called an instance of the class animal (Jacobson, 1992).

**d) Class hierarchy and inheritance:** Class may form a hierarchy, such that objects in any given class are automatically members of all its super class. All attributes and methods that apply to a class apply to its subclass as well. That is, methods and/or attributes defined in an object class can be inherited or reused by another object class (Whitten & Bentley, 1998; Cordes & Carves, 1992).

### **4.3. The design of National Herbarium of Ethiopia Database (NHEDB) and requirements**

The requirements of a NHEDB proposed for consideration is described as follows.

- Index records including the location of specimens both text and photographs.
- Records of the movement of specimens on that is loan or exchange, treatment, and display.
- bibliographic information related to research on specimen
- Display list of items by family, genus or species
- Security of information from invalid access

In the design of the database, the approach used by Lorenz is employed. The approach employs use case. Use case is a behaviorally related sequence of steps or scenario that are both automated or manually written for the purpose of completing a single business task. It is a description of the usage scenario in terms of the end user understanding and it is based on the tasks performed by the users (Whitten and Bentley, 1998; Lorenz, 1993). Whitten and Bentley, advocate that use case is:

- An effective tool for validating requirements.
- An effective communication tool.
- As a basis for a test plan.
- As a basis for a user's manual

In this design contracts are used together with use cases. Contracts are groupings of key, high-level responsibilities for a subsystem. They are delegated to class(es) within the

subsystem to service. The contracts are the architected interface to a part of the system (Lorenz, 1993).

Lorenz recommends the following steps to complete object oriented design:

1. Write Use cases:

- use cases are mini-scenarios for the system

2. Develop message flow diagrams for use cases (optional)

3. Develop collaboration diagrams.

- Collaboration diagrams graphically depict classes and subsystems, along with indications of other classes and subsystems they collaborate with.

Identify classes.

Identify class attributes.

Identify responsibilities (methods)

identify subsystems

identify contracts

contracts are key, high-level responsibilities for a class or subsystem

4. Place classes in the inheritance hierarchy.

5. Develop message flow diagrams for methods (optional).

6. Implement methods

7. Test methods

8. Develop function class

#### **4.4. Use cases of National Herbarium of Ethiopia Database (NHEDB)**

From the requirement list the following use cases of the NHEDB were derived to incorporate in the design:

- NHEDB access control
- Maintenance of index records of specimen and their specific location
  - create a record for a newly acquired specimen
  - update the record details of specimen and its location
  - delete the record
  - retrieve the index record (and its associated records)
- Recording of the movement of specimen with in and out of the herbarium
- Display/list specimen by family, genus, or species

The following section describes scenarios for use case.

## Fig 4.1. use cases

### USE CASE - ACCESS CONTROL

A machine is made available at different section of the herbarium to perform record maintenance and inquiry functions. The user is prompted for his/her password. If it matches with his password in the database, a menu choice of actions on the screen appears. If the password does not match, the user is shown

### USE CASE FOR WEB ACCESS

A server is kept at one of the section of the herbarium to perform browsing of records based on inquiries. The user is prompted for his password. If it matches with his password in the database, a menu choice of actions on the screen appears. If the password does not match, the user is shown a message on the screen.

### USE CASE CREATE INDEX RECORD

<USE CASE - ACCESS CONTROL is prerequisite> if create button is pressed, the user is allowed to enter the details. If the record exists a message appears on the screen, the new details will not be recorded. The user is allowed to then request another action or exit.

### USE CASE DELETE INDEX RECORD

<USE CASE - ACCESS CONTROL is prerequisite> if delete button is pressed, the user is asked specimen number. If the record exists, a message is displayed for conformation. If yes button is pressed, the record is deleted. The user is allowed to then request another action or exit.

#### USE CASE- RETRIEVE INDEX RECORD

<USE CASE - ACCESS CONTROL is prerequisite> if retrieve button is pressed, the user is asked specimen number. If the record exists, the detail of the record is displayed - otherwise a message appears. The user is allowed to then request another action or exit.

#### USE CASE - UPDATE INDEX RECORD

<USE CASE - ACCESS CONTROL is prerequisite> if update button is pressed, the user is asked specimen number. If the record exists, it is displayed and the user is allowed to change the details - otherwise a message appears on the screen. The user is allowed to then request another action or exit.

#### USE CASE MOVE SPECIMEN

<USE CASE - ACCESS CONTROL is prerequisite> if move specimen button is pressed, the user is asked specimen number. If the record does not exist a message is displayed - the user is asked the date, transaction no., the curator name, receiver's name, remarks and the destinations are displayed to allow him select. If he selects <display> a menu appears to select from the available location. The user is allowed to then request another action or exit.

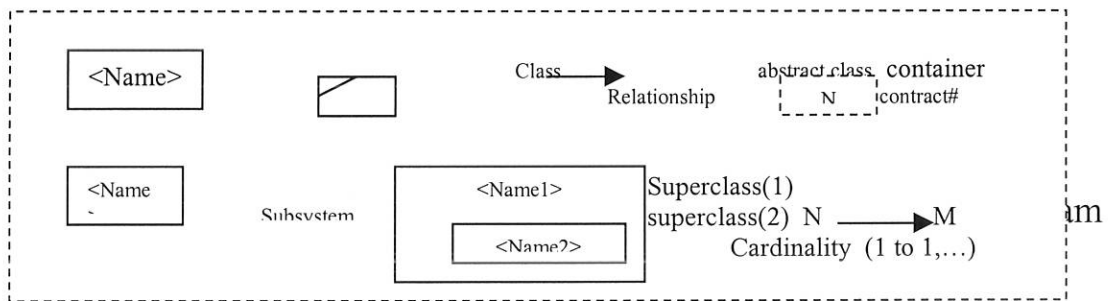
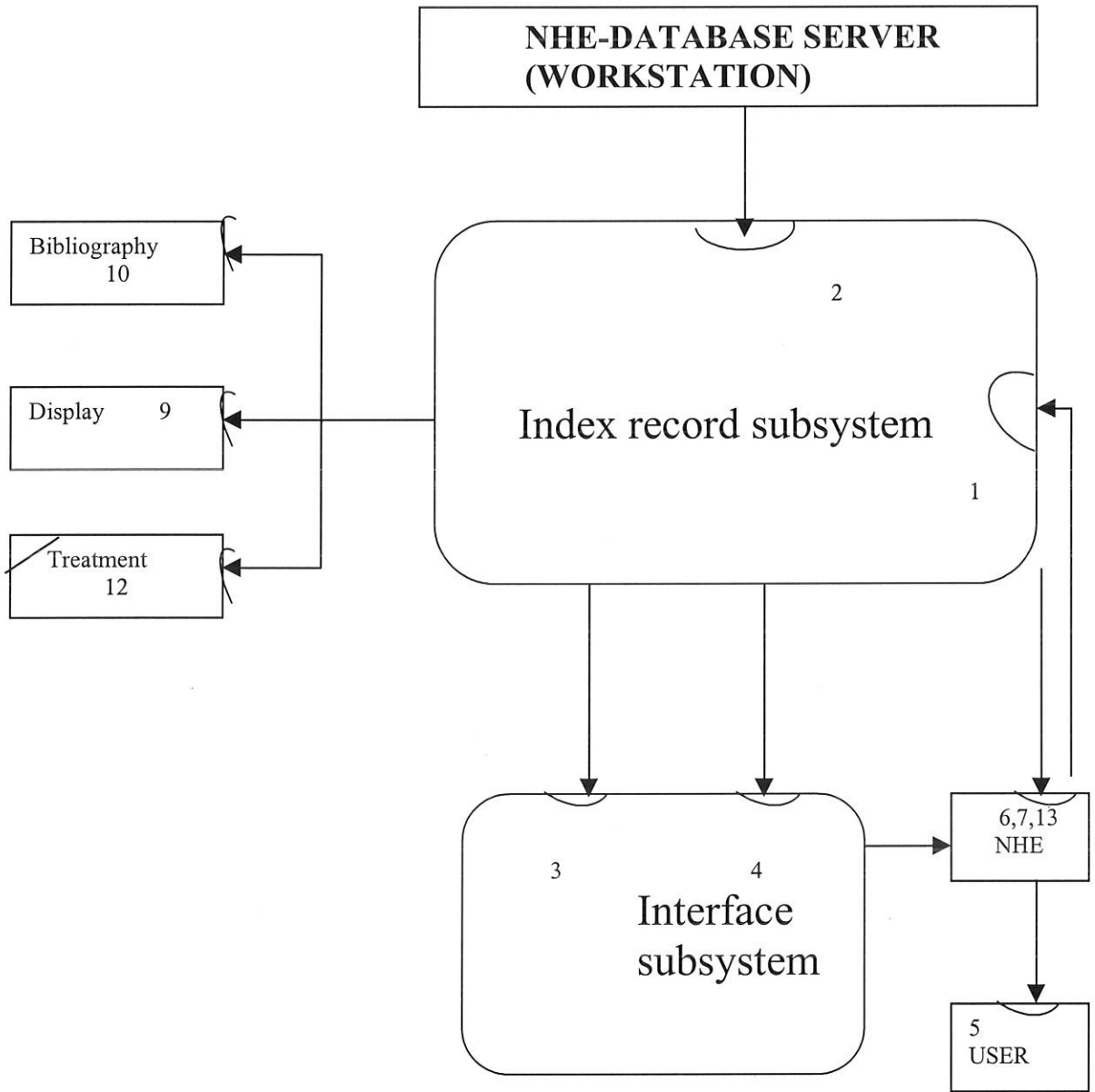
#### USE CASE FAMILY. GENUS. SPECIES SEARCHING

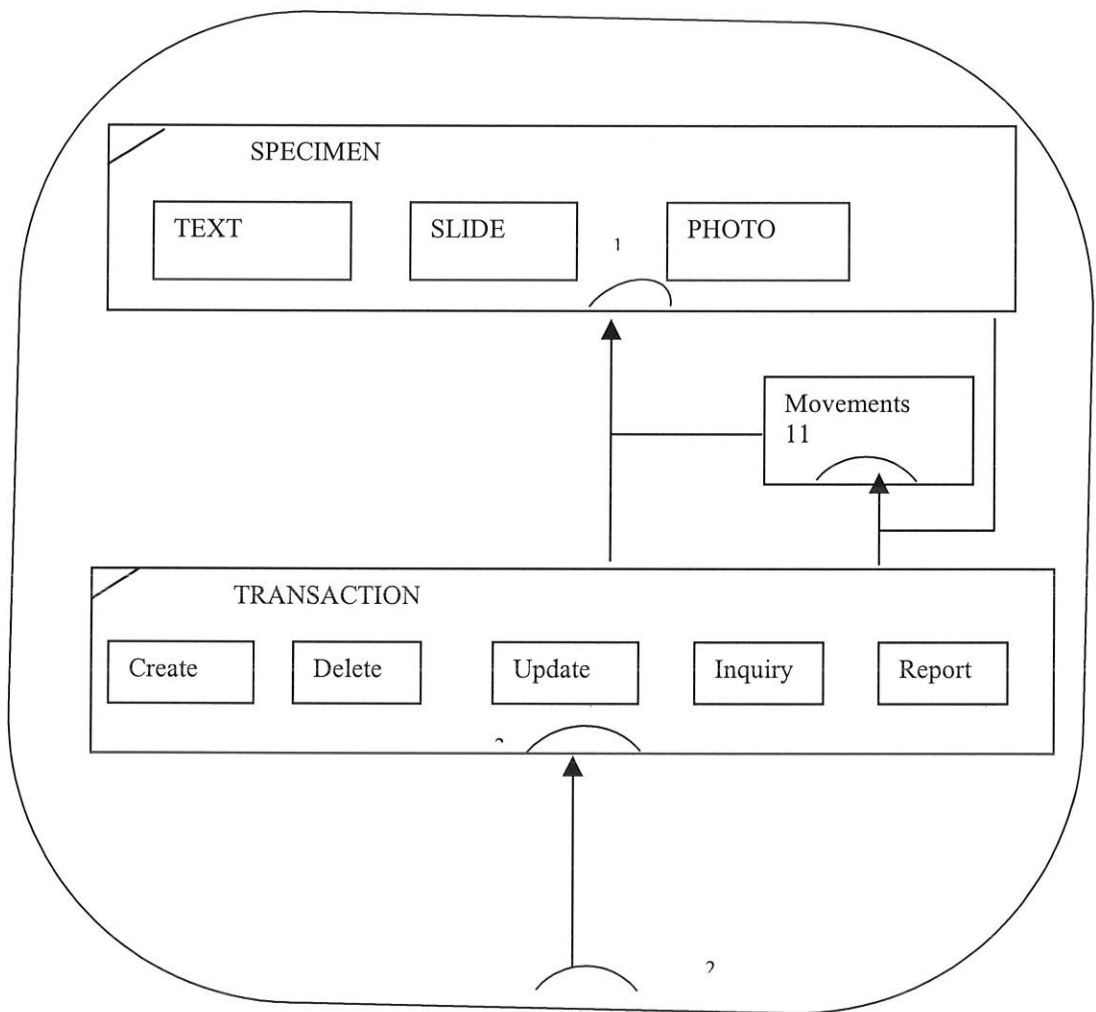
<USE CASE - ACCESS CONTROL is prerequisite> if family, genus, species button is pressed, the user is asked to enter one of the specimen name in this category and then all names matching the search argument are displayed. The user is allowed to then request another action or exit.

The following section provides collaboration diagrams of major subsystems, classes and contracts. It also presents class inheritance and relationships.

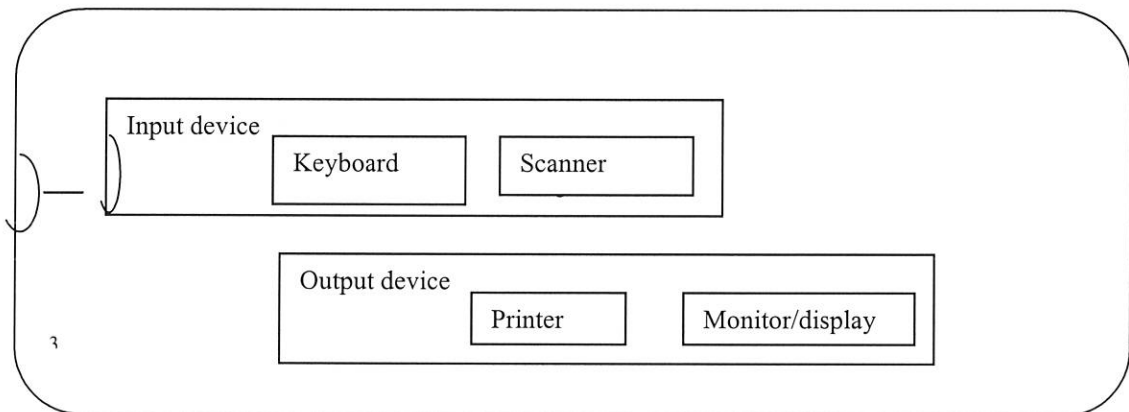
# NHEDBS Collaboration diagrams

Fig.4.2. Collaboration diagrams





Index record subsystem



Interface subsystem

## NHEDB SUBSYSTEM

Fig.4.3. National Herbarium of Ethiopia subsystems

### INDEX RECORD SUBSYSTEM

**DESCRIPTION:** coordinates the activities relating to the maintenance of the specimen index record and report generation

**CONTRACT**

**CLASS**

- [ ] Process transaction
- [ ] Maintain index record

**RESPONSIBLE**

transaction  
specimen

### Interface subsystem

**DESCRIPTION:** coordinates the device used by the database server (workstation) to transfer information to and from the herbarium users.

**CONTRACT**

**CLASS**

- [ ] Get user input
- [ ] Put output to the user

**RESPONSIBLE**

input device  
output device

Fig.4.4. NHEDB contracts

### CONTRACT 1 - MAINTAIN INDEX RECORD

**DESCRIPTION:** provide basic index record maintenance functions including create, update, delete and inquiry.

**Server**  
**Clients**  
movements

specimen  
create, update, delete, inquiry, NHE,

## CONTRACT 2 - PROCESS TRANSACTION

**DESCRIPTION:** process the index record maintenance and report generation service available at the NHEDS server (workstation) including create, update, delete, inquiry and report generation.

Server  
Clients

Transaction  
NHEDB server (workstation)

## CONTRACT 3 - GET USER INPUT

**DESCRIPTION:** Handles inputs from the user, including keyboard, and scanner.

Server  
Clients

InputDevice  
NHEDB server (workstation)

## CONTRACT 4 - PUT OUTPUT TO THE USER

**DESCRIPTION:** Handles outputs to the user including specimen information, display messages, lists.

Server  
Clients

OutputDevice  
Transaction

### **CONTRACT 5 - VERIFY PASSWORD**

**DESCRIPTION:** make sure that this user has a valid access password.

<b>Server</b>	user
<b>Clients</b>	NHE

### **CONTRACT 6 - VERIFY USER**

**DESCRIPTION:** make sure that this user is yours.

<b>Server</b>	NHEDBS
<b>Clients</b>	InputDevice

### **CONTRACT 7 - LIST SPECIMENS' DETAIL**

**DESCRIPTION:** Retrieve all your specimens that have a given family, genus, species name

<b>Server</b>	NHEDMS
<b>Clients</b>	Report

### **CONTRACT 8 - MAINTAIN DISPLAY RECORD**

**DESCRIPTION:** Provide basic display record maintenance function.

<b>Server</b>	display
<b>Clients</b>	Specimen, movement

### **CONTRACT 9 - MAINTAIN TREATMENT RECORD**

**DESCRIPTION:** provide basic movement record maintenance function.

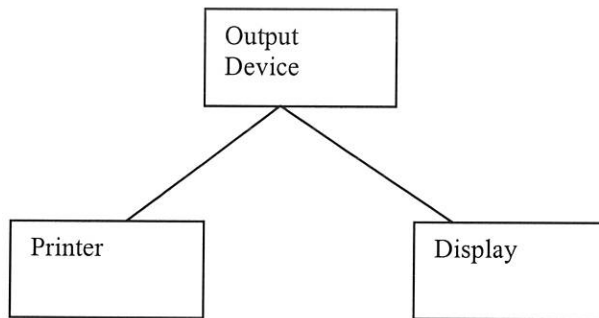
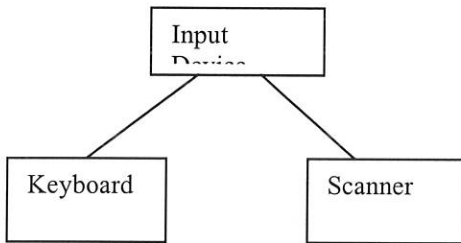
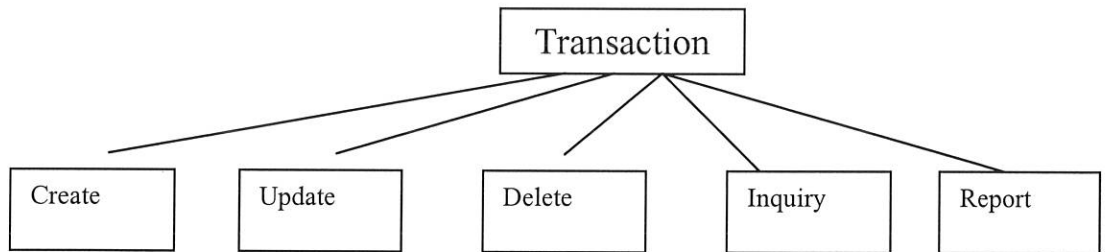
<b>Server</b>	Treatment
<b>Clients</b>	Specimen, NHE, user

### **CONTRACT 10 - MAINTAIN BIBLIOGRAPHY**

**DESCRIPTION:** provide basic Bibliographic record maintenance functions.

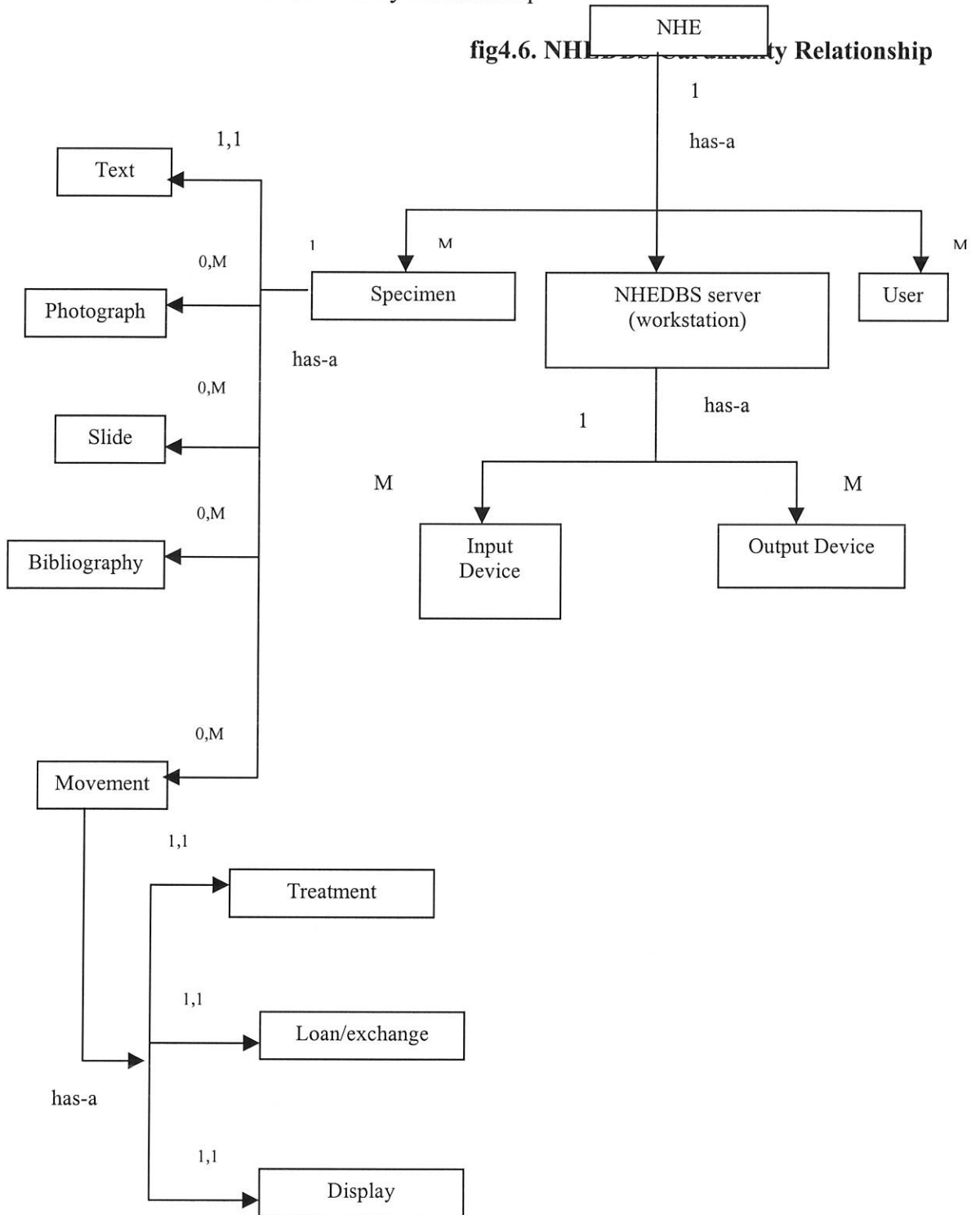
<b>Server</b>	Bibliography
<b>Clients</b>	Specimen

fig4.5. NHE Inheritance Hierarchies



NHEDBS Cardinality Relationship

fig4.6. NHEDBS Cardinality Relationship



## NHEDBS class definition

### INDEX RECORD CLASS

Description - the index record class is a data repository, maintaining indexing information of NHE. There is one instance of this class for each Indexing. Many specimens indexed and kept in a cupboard have one family name.

Superclass - persistentObject

Subclass - none

#### CONTRACTS

Maintain Index Record is implemented by this class.

Data

SpecimenNo

CollDate

Locality

Collector

Family

Genus

Species

CupboardNo

is kept

Description

the number given by the herbarium

the date on which the specimen is collected

the place where the specimen is collected from

the person who collected the specimen

family name of the specimen

Genus name of the specimen

Species name of the specimen

the cupboard in which the specimen

### BIBLIOGRAPHY CLASS

Description - the bibliography class is a data repository, maintaining bibliographic information that are related to the NHE.specimens. There is one instance of this class for each bibliographic material.

Superclass - persistentObject

Subclass - none

#### CONTRACTS

Maintain Bibliographic Record is implemented by this class.

Data

CallNo

Locality

collected from

Family

Genus

Species

Uses

Author

Imprint

ISBN

Number

List

document

Description

call number of the document

the place where the specimen is

family name of the specimen

Genus name of the specimen

Species name of the specimen

the use for which the plant is applied

author of the document

imprint information

the International Standard Book

list of family addressed in this

CREATE CLASS

Description - the Update class services the editing of specimen information. This transaction is created by the transaction class. This transaction is a transient object.

Superclass - Transaction  
Subclass - none

CONTRACTS

Process transaction is implemented by the following public method.

- a) CreateSpecimen:
- b) WriteSpecimenDetail:

RESPONSIBILITY

DESCRIPTION

CreateSpecimen: SpecimenNo  
WriteSpecimenDetail: SpecimenNo

Create a specimen record with SpecimenNo  
Write its detail for this specimen

DELETE CLASS

Description - the delete class services deleting of the NHE specimen's record. This transaction is created by the transaction class. This transaction is a transient object.

Superclass - Transaction  
Subclass - none

CONTRACTS

Process transaction is implemented by the following public method.

- a) DeleteSpecimen:

RESPONSIBILITY

DESCRIPTION

ConfirmDelete:  
delete.  
DeleteSpecimen: SpecimenNo

ask the user for conformation to  
delete.  
delete specimen with idetification: SpecimenNo

### DISPLAY CLASS

Description - the display class is a repository class maintaining information about specimens that are out for display purposes. There is one instance of this class for each display.

Superclass - PersistentObject

Subclass - none

#### CONTRACTS

Maintain display record is implemented by this class.

#### DATA

SpecimenNo

herbarium

CollDate

Locality

collected from

Collector

Family

Genus

Species

CupboardNo

specimen is kept

DispStartDate

started

DispEndDate

#### DESCRIPTION

the number given by the

the date on which the specimen is collected

the place where the specimen is

the person who collected the specimen

family name of the specimen

Genus name of the specimen

Species name of the specimen

the cupboard in which the

the date on which the display is

the date on which the display is

### NHEDB SERVER (WORKSTATION) CLASS

Description - the NHEDB server(workstation) class is responsible for providing collection management services available for NHE users, creating the appropriate Transactions. There is one instance of this class for each workstation.

Superclass - specimen

Subclass - none

Contacts - none

#### RESPONSIBILITY

aCreateTransaction:

anSpecimenNo:

wants to take action.

ASpecimenInformation:

AspecimenName:

Iterate:

#### RESPONSIBILITY

ConfirmDelete:

delete.

DeleteSpecimen: SpecimenNo

SpecimenNo

#### DESCRIPTION

Initiate the appropriate transaction.

Get the SpecimenNo the user

Get the specimen's information the user wants to update or create a new one

Get the object name to list all specimen with the same family, genus or species

allow user to request another action.

#### DESCRIPTION

ask the user for conformation to

delete specimen with idetification:

## NHE CLASS

Description - the NHE class provides handles requests about its specimen and users. There is only one instance of this class.

Superclass - persistentObject

Subclass - none

### CONTACTS

Verify User is implemented by the following methods:

- a. ValidateUser

List Specimen's Details is implemented by the following public methods:

- a. ListSpecimenDetail:

Verify object's existence is implemented by the following public methods:

- a. ValidateSpecimenNo:

### RESPONSIBILITY

ValidateUser: anInteger

ValidateSpecimenNo: anSpecimenNo

ListSpecimenDetail: a specimenName

### DESCRIPTION

compare an integer to my user. Return true if it is equal, false otherwise.

compare an SpecimenNo to my specimen. Return true if it is the herbarium's object, false otherwise

compare a specimen name to NHE SpecimenName. For matching instances, return their details.

### DATA

Specimens

Users

NHEDB\_server (workstation)

### DESCRIPTION

list of the NHE specimens

list of valid users of the system

list of available workstations

### REPORT CLASS

Description - the report class services the retrieval of specimens using certain characteristics. This transaction is created by the transaction class. This transaction is a transient object.

Superclass - transaction  
Subclass - none

#### CONTRACTS

Process transaction is implemented by the following methods:

- a) SimilarSpecimenDetail

#### RESPONSIBILITY

SimilarSpecimendetail; aSpecimenName

#### DESCRIPTION

list for the user all specimens with name: aSpecimenName

### SPECIMEN CLASS

Description - the specimen class is an abstract class that provides common services for all types of herbarium objects.

Superclass - persistentObject  
Subclass - text, photo, slide

#### CONTRACTS

Maintain index record  
(all the methods are listed below under RESPONSIBILITY)

#### RESPONSIBILITY

SpecimenNo:  
FamilyName:  
CollectorName  
Locality  
uses  
applied  
CupboardNo  
specimen is kept  
CollectionDate  
CollectionDate  
Remark

#### DESCRIPTION

Return the SpecimenNo of a specimen  
return the Family name of a specimen  
return the name of the collector  
return the name of the place where the specimen is collected from  
return the use for which the plant is  
return the board number where the  
set the CollectionDate to  
return the remark

## CHAPTER V

### PROTOTYPE DESIGN

#### 5.1. INTRODUCTION

Due to time limitation of time it was not possible to develop a prototype for all the classes described in the previous chapter. Since the transaction class represents most of the complexities of the system, the prototype database was developed for the transaction class. From the transaction class CREATE, EDIT, and UPDATE subclasses were implemented. The applications used to develop the prototype were Microsoft Access, Cold Fusion studio and old Fusion Application Server, Personal Web Server and Internet Explorer.

Cold Fusion is a web application development tool that enables the rapid creation of interactive, dynamic, and information-rich web sites. Cold Fusion does not require coding in programming languages. It facilitates the creation of application by extending a standard HTML files with powerful formatting functions, conditional operators, and database commands.

Cold Fusion is capable of accessing varieties of databases by making use of Open Database Connectivity(ODBC). Hence a 32bit ODBC driver was used to specify the data source name and the database name for Cold Fusion. ODBC is an Application Program Interface (API) that provides access to databases, even data such as text, spreadsheet, and Indexed sequential Access Method (ISAM) files (North, 1995).

A personal web server was used to mount the database and run Cold Fusion. The Microsoft Personal web server found appropriate as a low-volume server for testing. It could be used as the main server for a low-volume Intranet at a small company or organization (Lehoto and

polonsky, 1996). Personal Web Server was used for its simplicity in configuration and availability. It can also be run on a stand-alone computer.

The personal web server is based on National Center for Supercomputing Application (NCSA) standards, and it fully support Hypertext Transfer Protocol (HTTP) and common gateway interface (CGI) scripts, so one does not need to be concerned with writing new scripts using Cold Fusion.

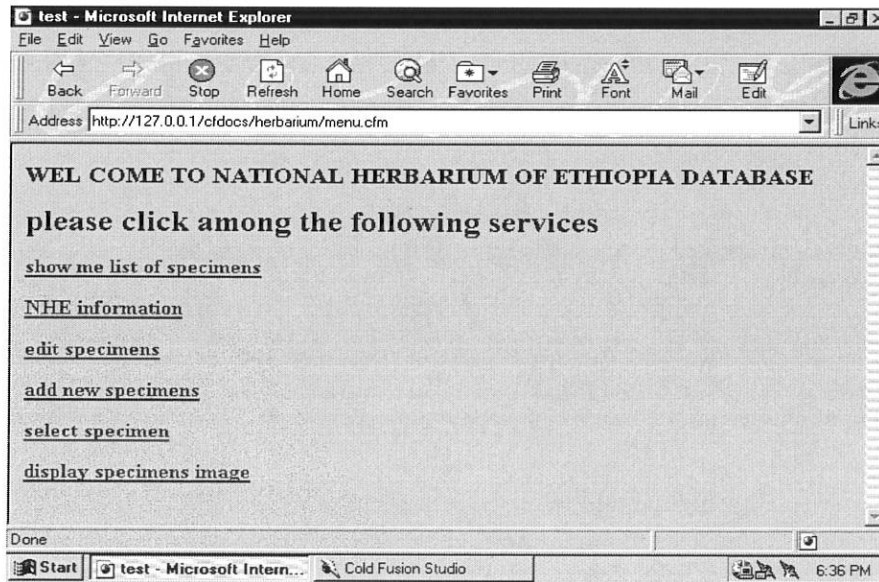
The architecture used by Cold Fusion is Client/server architecture. In its most basic form, client/server technology centers on a network of computers, some of which are clients and at least one of which server (Martin and Weadock, 1997).

The client computers are usually the ones most visible—typically desktop computers dedicated to the needs of a single human being. For this prototype implementation the client is Internet Explorer. Users access the available data kept in the database by simply browsing using Internet Explorer.

Server computers, on the other hand, are virtually always shared. The server provides services to some or all of the clients hooked up to the network. In our case cold fusion application server, personal Web server and the application developed for this prototype are kept on the server and clients can access them using Internet explorer. However, in this prototype both the servers (personal web server, the Cold Fusion Application server) and the Client are found on one desktop.

## 5.2. DEMONSTRATION OF THE PROTOTYPE

The prototype starts by simply running Internet Explorer. When users run the Internet Explorer the homepage will be the Welcoming screen of the prototype.

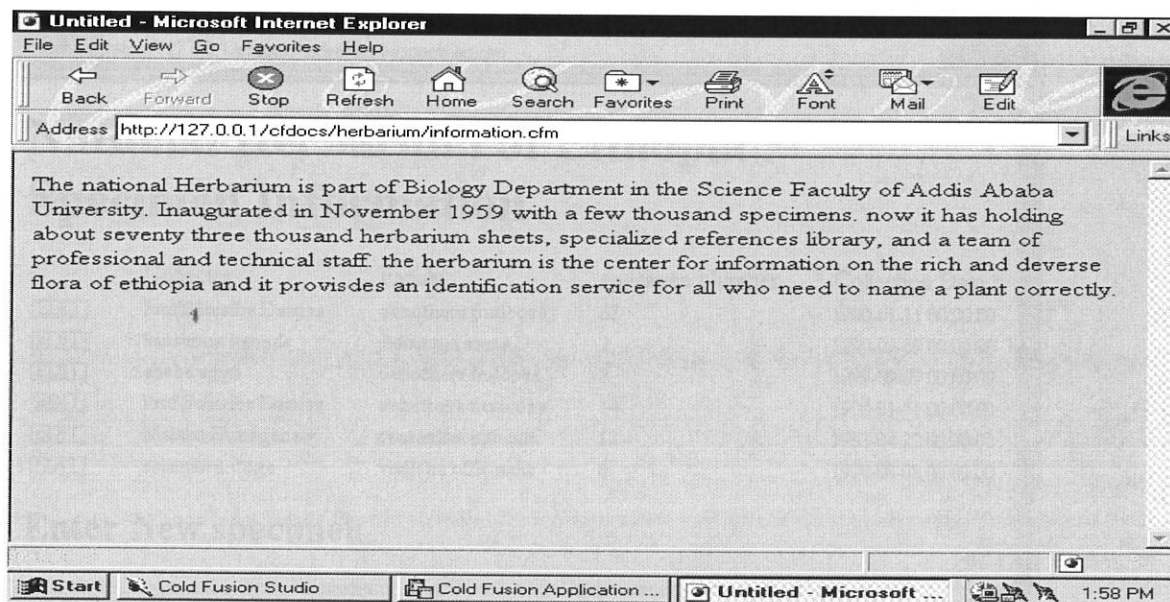


**Fig 5.1. Welcoming screen**

This screen requests user to click on one of the links available on the page. This page also introduces the NHE to the user.

When Information about the NHE is clicked the following page will be displayed.

**Fig. 5.2 information screen**



This page introduces the NHE for the users.

When show me specimen link is clicked the following page will appear.

## CHAPTER VI

### 6.1. CONCLUSION AND RECOMMENDATION

#### 6.1.1. CONCLUSION

The thesis has been dwelt upon investigating the solution to alleviate the existing information service problem of the NHE. In the course, attempts have been made to review literatures on herbarium, object-oriented systems analysis and design, web accessible databases in general and web accessible herbarium databases in particular. These helped the researcher to have a clear understanding on the problem area and to design a database solution.

The survey revealed that the existing information system is inadequate for the majority of the users. It also showed that the access points to the collections are limited. The assessment of the existing resources showed that the proposed system could be implemented using the existing resources with the addition of few more. In the database structures attributes are included that reflect the information content of the National herbarium of Ethiopia (NHE). The search interface developed in the prototype used the Cold Fusion forms to extract data from and to submit data into the database developed using Microsoft Access. End users are made use of the prototype and commented upon it. Based on the users comment additional modifications has been made and encouraging results have been obtained. The researcher firmly beliefs that the result of this undertaking would help the center as well as similar institutions as a starting point for the development of similar systems locally.

### 6.1.2. RECOMMENDATIONS

As indicated in the first chapter, it is not the purpose of this study to come up with a full-fledged operational database system. The study attempted to show the need, design considerations and demonstrate the possibility of using web based database application. Therefore, it is recommended that the NHE extend the result of this study by implementing the rest of the classes that are not treated in this study. Appropriate guidelines for mounting the herbarium information in web accessible format and how data should be accessed and who should access the database should be developed. In addition

- The NHE needs a web server to mount its database. So far there is no web server provided by the Internet Service Provider in the country. Thus the center has to look for server outside of the country. However, the NHE can make use of its database by upgrading the LAN so that it could support web-based application. If this can be achieved, it would help researchers to access the database from workstations.
- The center has to use the best data compression technique to make its information available (both text and photograph) on specimen on line. Pictures take much memory and disks space and take sometime while they are being transmitted on line.
- The center has to consider applying a package that can fully support object orientation feature for the implementation of a full-blown database system.
- The center has to have professional who can administer the database.

Moline, J. (1991). "**Designing Multimedia systems for museum objects and their documentation**". Microcomputer for information Management 8(2): 69 - 86.

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North, Ken (1995). **Windows Multi-DBMS programming using C++, ODBC, OLE2, and Tools for DBMS Projects.** New York: John wley & sons, Inc.

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Prabhakaran, B. (1997). **Multimedia Database Management Systems.** Boston, London/Dordrecht: Klume Academic Publishers.

Saracevic, T. and Wood, J.B. (1981). **Consolidation of information: A handbook on evaluation, restructuring, and repackaging of scientific and technical information (Pilot ed.).** Paris: UNESCO.

SMASH (Specimen management Systems for California Herbaria)  
([http://ucjeps.herb.berkeley.edu/smash\\_dist/index.htm](http://ucjeps.herb.berkeley.edu/smash_dist/index.htm))

Tefera, D. (1992). "**National Herbarium [Ethiopia]: from where to where?**" African research and Documentation. No.59/60.

**ADDIS ABABA UNIVERSITY**

**SCHOOL OF INFORMATION STUDIES FOR AFRICA (SISA)**

**DISCUSSION GUIDE FOR NATIONAL HERBARIUM OF ETHIOPIA USERS**

I. IDENTIFICATION

What is your occupation?

What is your educational background?

What kind of problem you are working on?

ASSESSMENT OF INFORMATION REQUIREMENTS

1. How do you get information about specimens that you are looking for?

From the printed Flora  by searching the physical collection(specimens) of the institute [  
] others

2. Is the current level of information provision adequate?

If yes, why?

3. If no, what additional information, search and retrieval tools do you say are necessary?

Family index  genus index  species index  others, please specify

4. Have you ever used Internet?

5. If yes, have you ever come across herbarium information (databases) while you were surfing the Internet?

Databases       CD-ROM

6. If yes, do you think that it is important to make the collection of the herbarium web accessible? What do you think the potential pitfalls would be?

7. Do you think that the use of web accessible multimedia database in the center facilitate your access to the herbarium irrespective of where your institution is located?

8. Any relevant information that you think is important for this study.

## II. ORGANIZATION

1. What is the objective of the herbarium?
2. What are the information related activities and services of the herbarium?
3. What types of collection do you have or what type of herbarium is it?
4. How is the herbarium is structured (organizationally), managed and financed?

## III. USERS

5. Who are the major users of the Herbarium?

Researchers, \_\_\_\_\_ Institutions \_\_\_\_\_  
Visitors \_\_\_\_\_ Students \_\_\_\_\_  
Instructors \_\_\_\_\_ Others \_\_\_\_\_

## IV. COLLECTION TYPE AND SYZE

6. What media (and in what average size) are included in your collection?

Specimens mounted on paper \_\_\_\_\_  
Photographs of specimen \_\_\_\_\_ slide \_\_\_\_\_

7. On the average what is the monthly addition of each type? (On what basis is the collection is acquired and what is the interval, if any?)

Specimens \_\_\_\_\_ Photographs of specimens \_\_\_\_\_  
Slide \_\_\_\_\_

V DOCUMENTATION SYSTEM

8. What type of collection documentation system do you use?

Please specify

9. Do you maintain indexes?

10. In the existing manual system, how are the indexes are organized?

By accession number  by family, genus, species, etc.

11. Does the index contain complete and up-to-date information?

12. How much does it take to get information on a specimen from index for some purpose such as record updating, retrieving, item's location, etc.?

Less than one hour  one hour  two hours

Half a day  or more

13. How do other users (for example researchers) use the index?

By their own  through the help of the technician  others

14. How specimens are physically organized in the herbarium?

Accession number.  Family, genus, species  others

15. Is it possible to take inventories of your specimens at the required frequency and with an acceptable time?
16. How easy is the identification of lost and deteriorated specimens?
17. Do you keep photograph documentation other than specimen?
18. Does the existing documentation system facilitate the selection of specimens (for conservation, and research purposes) without browsing through the physical items?
19. Do you use any standard input format (regional, or international) for indexing information?
20. Do you have any classification scheme for categorizing your specimens?
21. Do you have terminology lists for different categories of information that can help you describing the specimens consistently or aid at the time of searching (e.g. family, genus, species, etc.)?
22. Does the indexing system provide sufficient cross-references to related information: family, genus, species, etc.

23. Does the documentation (indexing) system facilitate in retrieving an integrated information about a specimen timely? If no, does it affect your work:

Very much     little     not at all

24. What publications you are usually required to produce from your collection? Can you do it at required frequency and quickly?

25. Can you easily prepare supplementary interpretive materials (labels, guides, etc.)?

26. What types of information do you need or already maintained other than indexing information to facilitate your work?

**Collections management information**

Indexing     photography     loan/Exchange  *disposition*

**Conservation related information**

Treatment information                       treatment methods/techniques                         
records of conservation information

**Research related information**

Bibliographic information                       determination list

**Others**

27. How quickly do visitors able to locate information using the card index?

Less than half an hour    one hour    two hours    half a day

28. Do you think the use of automated systems that provide all types of information improve the Herbarium service?

29. Is there any information flow between you and other units of the herbarium or outside the herbarium?

30. Is there any collaboration programs for sharing specimens and their information from similar institution for research or other purpose?

## **VI. GENERAL**

1. Where do you think the users of the herbarium face problems while they are looking for information?

2. To what extent the objectives of the herbarium met?

3. What should be put in place in order to solve fully or partially the current problems and raising the overall levels of your performance?

## **VII. OTHERS**

1. Is there any plan to automate the system?

2. If there is, what type is it?

A conventional automated system:

A replacement of the manual system

With additional features such as the ability of the creation and use of indexes and other retrieval tools

Automated system that:

Integrates all types of information: text and pictures.

3. What main features/facilities do you expect an automated system should provide you with?
4. What will be the benefit for your herbarium to automate?

## **5. INTERNET**

- Do you use Internet as a means of getting information?
- Have you ever come across a herbarium databases on the Internet?
- If yes, how often do you visit these herbarium databases?
- Do you think that it is important to make your herbarium collection accessible via WWW? What benefits and pitfalls do you think it would have?

## **BENEFITS**

- It can be accessible to various institutions in the country that have interest in the herbarium.
- Loan and exchange transaction can be made with sisters institution that are found abroad.
- It can be made accessible on subscription basis.
- It can promote the available indigenous and endemic of plants of Ethiopia to the outside world.
- It can be authoritative source of information on plants available in Ethiopia.

## **PITFALLS**

- The security of the data available in the center will be threatened.

## **VIII. RESOURCE AND FACILITY**

1. What type of IT facility do you have at the institute?

Computers     software     application programs     printers     [ ]  
scanners     digital camera     CD-ROM    others \_\_\_\_\_

2. If you have, for what purpose do you use them?

Office and business functions(word processing, electronic mail, payroll, etc.) [ ]  
Collection management     statistics    others \_\_\_\_\_

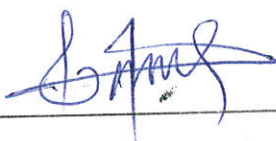
3. How do you plan to financing of the automation?

Own fund     government funds     funds from other organization

4. other relevant information:

## DECLARATION

The thesis is my original work and has not been presented for a degree in any other university.



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Wondimench Mammo

May, 1999

The thesis has been submitted for examination with my approval as university advisor.



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Dr. Lishan Adam

May, 1999