Agricultural Libraries and Information Centres in China: Co-operation, Resource-sharing and Networking

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[1] Adopted from Leimkuhler

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"Any breakthrough ... is likely to come from outside the system. 'Experts' are the most thoroughly familiar with the developed knowledge inside the prescribed boundaries of a given science. Any new knowledge must usually come from the outside—not by 'expert,' but by what someone has defined as an 'inpert'."

—Maxwell Maltz

Declaration

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Abstract

This research is aimed towards the design and planning of an agricultural library and information network in China. Systems approach is applied to the construction of descriptive, mathematical and hybrid (logical) models in the design phase of the system development cycle.

Four major conventional network functions are chosen as core functions to be designed in detail. A number of procedures and issues are identified for both overall network and individual function design. The embodiment of the design is based on the particular context to which it relates. The results of the design are presented by either descriptive, or mathematical or hybrid (logical) models, decided by the categories of issues (quantitative or qualitative, or hybrid). The impacts of new technologies are explored and three alternative programmes, dependent on the technologies to be applied, are defined.

The cost-effectiveness-benefits of the services as overall criteria, and AHP (Analytical Hierarchy Process) as an processing tool, help determine 1) which program will be run, computerised or non-computerised (by cost-benefit analysis); and 2) for a particular program, the resource allocations (mainly budgets) among co-operative activities and the resource allocations within the activity, i.e. two-level allocations.

Zhejiang province, one of 29 provinces in the country, is taken as an example of regional (provincial) network model. Twenty-eight nodes from five sectors and three levels, plus more potential nodes, will be configured hierarchically within the respective sectors and, in decentralised mode among sectors, in terms of network management. But, in terms of information flow and transaction, the configuration will be a mixed one.

The purposes of data collection are identified at four stages of network planning, i.e. investigation of situation, theory-testing, explanation of model and prediction. A number of investigations were made to fulfil the objectives of data collection. The descriptions of those investigations are given and the results are discussed. The barriers to data collection confronted in Chinese circumstances are presented. Statistical analyses are carried out for certain types of data 1) to seek the conformity with the empirical assumptions, 2) to help set objective measures, 3) to estimate parameters and co-efficiency, and 4) to derive some mean, average and unit values.

The research has focused on the organisational aspects of networking. However, the macro-consideration of technology is inevitable since it is a time of technological change. The latter stages of mathematical modelling, i.e. optimisation, prediction and validation are left until more numerical data become available. Nevertheless, it is possible for the author to make recommendations about the development of agricultural library and information networks in China.

Acronyms and Abbreviations

AGRICOLA	The NAL (National Agricultural Library) bibliographic database
AGRINDEX	The printed index produced by AGRIS
AGRIS	International Information Systems for the Agricultural Science and Technology
AHP	Analytical Hierarchy Process
AIR*	Agricultural Information Resources
ALA	American Library Association
ASIS	American Society for Information Science
BIOSIS	BioScience Information Services
BA	Biological Abstract
CA*	Co-operative Acquisition
CAB	Commonwealth Agricultural Bureaux
CALA	Chinese Agricultural Library Association
CAP*	Co-operative Acquisition Programme
CAS	Chemical Abstracts Service
CEB	Cost-effectiveness-benefits Analysis
COM	Computer Output Microform
CD-ROM	Read Only Memory Compact Disc
CRA	Current Research Abstracts
CRIS	Current Research Information System (USA)
CT	Chemical Titles
CB*	Chinese Books
CP*	Chinese Periodicals
DIALOG	Set of computer programs for online information retrieval produced by Lockheed Information Systems
DR*	Duplicated Rate
DSS	Decision Systems Support
EUSIDIC	European Association of Scientific Information Dissemination Centers
ESA-IRS	European Space Agency Information Retrieval System
FAO	Food and Agricultural Organisation of the United Nations
FB*	Foreign Books
FP*	Foreign Periodicals
FSTA	Food Science and Technology Abstracts
GPSS	General Purpose Simulation Systems
IAALD	International Association of Agricultural Librarians and Documentalists, now renamed International Association of Agricultural Information Specialists

IDRC	International Development and Research Centre (Canada)
ILLINET	The ILlinois Library and Information Network
ILL	Interlibrary Loan or Interlending
IR	Information Retrieval
ISTIC	Institute of Sci-tech Information in China
JAUL*	Jielin Agricultural University Library
K-S*	Kolmogorov-Smirnov Test
LASER	London and South Eastern Region (network)
MARC	Machine Readable Catalogue
MEDLINE	Medical Analysis and Retrieval System On-line
NAL	US National Agricultural Library
NCLIS	The US National Commission on Library and Information Science
NLB	National Library of Beijing
NLM	US National Library of Medicine
OCLC	Ohio Online Computer Library Centres, former Ohio College Library Centres
OR	Operations Research
ORBIT	On-line Retrieval of Bibliographical Information Time-shared (on-line retrieval software produced by System Development Corporation)
PDN	Public Data Switch Network
PEPS-UNESCO	Population Education Programme Services, UNESCO.
PERT/CPM	Programme Evaluation & Review Techniques/Critical Path Methods
PGI-UNESCO	General Information Programme, UNESCO
RLG	Research Library Groups
RLIN	Research Libraries Information Network
RS	Retrospective Searching
SDC	System Development Corporation
SDI	Selective Dissemination of Information
STDIC&CAAS	Sci-tech Information and Documentation Centre of Chinese Academy of Agricultural Science
TWX	Teletypewriter Exchange Services
UAP	Universal Availability of Publication
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNISIST	United Nations Information System in Science & Technology
UTLAS	University of Toronto Library Automation System
WLN	Washington Library Network
ZALINET*	Zhejiang Agricultural Library and Information Network

*Used by the author

List of Agricultural Libraries & Information Centers in Zhejiang Province

CNRRI	China National Rice Research Institute
HAHS	Hangzhou Agricultural High-School
HARI	Hangzhou (Prefectural) Agricultural Research Institute
HAS	Hangzhou (Prefectural) Agricultural School
JARI	Jiashan (Prefectural) Agricultural Research Institute
JAS	Jiashan (Prefectural) Agricultural School
JSRI	Jiashan Silk-worm Research Institute
JHARI	Jinhua (Prefectural) Agricultural Research Institute
JHAS	Jinhua (Prefectural) Agricultural School
LARI	Lishui (Prefectural) Agricultural Research Institute
LAS	Lishui (Prefectural) Agricultural School
NARI	Ningbo (Prefectural) Agricultural Research Institute
NAS	Ningbo (Prefectural) Agricultural School
SARI	Shaoxing (Prefectural) Agricultural Research Institute
SAS	Shaoxing (Prefectural) Agricultural School
TARI	Taizhou (Prefectural) Agricultural Research Institute
TAS	Taizhou (Prefectural) Agricultural School
TRI	Tea Research Institute (CAAS)
WARI	Wenzhou (Prefectural) Agricultural Research Institute
WAS	Wenzhou (Prefectural) Agricultural School
ZAAS	Zhejiang Academy of Agricultural Sciences
ZSRE	Zhejiang School of Rural Economy
ZAD	Zhejiang Agricultural Department
ZARI	Zhoushan (Prefectural) Agricultural Research Institute
ZASO	Orange Research Institute of Zhejiang Academy of Sciences
ZAU	Zhejiang Agricultural University
ZISTI	Zhejiang Institute of Sci-tech Information
ZL	Zhejiang Library
ZTCRI	Zhejiang Sub-tropical Crops Research Institute

Introduction

Context of the Study

Impetus and Motivation of Networking

According to the Oxford English Dictionary, the term "network" has existed since 1560. Confusion over what constitutes a network has continued ever since. Indeed, it seems that, as network-like activities proliferate, precision in the use of the term declines. (Miller & Tighe, 1974)

One of the major reasons why libraries and information centres join together in networks is to share resources. More and more of them realised that not one single library or information centre can handle the voluminous amount and range of information currently available and expected to be generated in the future. In recent years, the purchasing power of libraries has decreased while their service goals have increased. The developments have influenced many a library or information centre to view a "collection" as including not only the materials it owns but also the materials owned by other libraries or information services with which it maintains a certain level of co-operation.

As a general term, *resources* can include materials, equipment, people, time, and money. As applied to libraries and information centres, sharing of resources usually means the sharing of library materials and other information resources, so that several geographical scattered organisations acting in a co-ordinated fashion can eliminate some purchasing and processing costs. More and more, however, resource-sharing has come to mean the sharing, or pooling, of equipment and services, as well as of library materials, as time-sharing and computer-based library networking activities increase.

The substantial benefits yielded by networks cannot be doubted. However, it should be made clear to potential members that benefits may vary depending, in the first place, on the effort they exert to achieve such benefits. In other words, in view of the fact that the consequences of network participation are far-reaching, members must naturally adopt healthy and favourable attitudes towards networking. To accommodate all the network functions satisfactorily, significant investment would have to be made by members in terms of ensuring effective communications and in sharing their resources as well as their capabilities.

Evolution of Library and Information Networking

Library network is not a new concept, especially in advanced countries. The concept of library network emerged during the mid-1960's. But the long tradition of co-operation among libraries in many countries can be traced back at least 100 years.

The present decade, however, has seen a greatly renewed interest in co-operation and mutual involvement; the difference now is the increase in the use of the term "network" in the place of "co-operative system".

The need for library and information networks and the variety and similarity of the services offered depend on the size of the country, population distribution, the level of political and social awareness, technological development, and background history of library development. The highly structured hierarchical systems developed in the USSR, the German Democratic Republic and other East European countries, is quite different from the multiplicity of networks that have grown up over the years in the USA, UK, Western Europe.

World-wide, there now exist many successful library and information networks, such as OCLC (Now Ohio Online Computer Library Centres, shared cataloguing network), WLN (Washington Library Network, Multiple services network), and LASER (London and South-east Region, regional library system) etc.

OCLC went online in 1971. More than a decade of effort since then has given the four major utilities—OCLC, RLIN (Research Libraries Information Network), WLN, and UTLAS (University of Toronto Library Automation System)—and some regional networks a stability that is as remarkable as it is necessary.

Bibliographic utilities have continued to expand their range of services and the number and variety of their users. OCLC is still the giant in the field and continues to consolidate its position.

In UK, development taking place within the British Library, especially in Document Supply Centre (former Lending Division), have influenced the operational pattern of the country's other library and information systems. The centralised interlending services have been significantly effective in this country. Meanwhile, LASER, the largest of the regional library systems has been a good supplement to the centre for unfulfilled requests. Membership of LASER, approached 60 in late 1970's. LASER is now extending its realms of influence particularly in the field of periodicals; it receives many requests for assistance in locating highly specialised journals with limited distribution. (Burkett, 1979)

Most networks are extending their services. The trends are towards high-degree of computerisation, multitype, multi-function and commercialisation.

Stimulus to this Project

Networking in China can be traced back to the late 1950's. Facilitated by the establishment of Central Libraries Committees, various scales of professional or geographical networks formed to carry out Interlibrary Loan, Union Catalogue and other co-operative activities. Nevertheless, these networks were paralysed at their early stage by the "Cultural Revolution". Since 1976, library and information services have entered a period of recovery. And now the whole of China's library and information system is aimed at catching up modern developments. With similar impetus, many libraries have started to realise that networking is one of the most effective way of relief. But many of them are puzzling about what models they should adopt. They have realised that they should learn from the advanced countries, in terms of experiences and technologies but must not copy the western models since the situations, in terms of politics, economies and technologies etc. are so different. Chinese library and information systems are seeking models adaptable to Chinese circumstances. As one of the seekers, the author has chosen this research project and aimed at urging the idea of networking and of designing a suitable model.

The objectives of the study can be stated as follows:

1. To construct *descriptive, mathematical and hybrid models* for the design and planning of a Chinese agricultural library and information network (focusing on provincial scale);
2. To seek the *methodologies* best adaptable to the design and planning of such networks;
3. To propose the *future development* for agricultural library and information networks in China.
4. To urge upon the Chinese authorities, and library and information systems, the *importance of networking.*

The models constructed should represent the Chinese realities well; and their credibility and reliability should be good enough convincingly to fulfil the objectives of the model building.

It should be pointed out that this project is aimed at focusing on the *organisational* aspects of networking though the consideration of *technological* aspects is inevitable in the present technological age. Most mathematical models constructed remain at their theoretical stages and serve the purposes of identifying trade-offs, quantitatively and qualitatively.

The implementation of the models is the ultimate goal; it will need great effort.

Methodologies applied to the design and planning of library and information networks

Library and information networks are complex information systems. The design of such systems requires scientific methods, or the "systems approach". System design is one important

phase of the system development cycle. The overall system development cycle entails five or more phases, beginning with an existing system to be investigated and analysed and culminating in a new system that in turn may lead to the beginning of another new cycle. Thus system design may overlap system analysis.

System design, system analysis and model building are inseparable notions. To describe and design a system means that we construct some kind of representation or model of it. Based on the careful literature search and recognition of the problem areas, the author feels that it is desirable to construct descriptive, mathematical and hybrid models for the design of the network. Each of the three types of model has its own advantages and disadvantages, but a combination of them is expected to be more reliable and effective in representing the reality.

The research methods assisting the construction of those models are varied and versatile: some of them can serve multiple purpose, i.e. the constructions of either descriptive or mathematical models. One good example is the *survey* method, which can collect both quantitative and qualitative data and lead to quantitative and qualitative conclusions.

Organisation of the Thesis

The text has been organised as a logical progression in the following stages.

Part One: Theoretical Considerations

Three issues have been considered as important theoretical preparations for the practices of design and planning. They are 1) The state-of-the-art of co-operation, resource-sharing and networking (*Chapter One*); 2) The design and planning of information systems (*Chapter Two*); and 3) The review of Methodologies (*Chapter Three*).

In *Chapter One*, definitions are given of the concepts of co-operation, resource-sharing and networking in the information world: they are mostly synonymous. Components, impetus and barriers to networking are identified in general terms.

In *Chapter Two*, concepts of systems, information systems and system design are clarified. Other researchers' "how-to" studies are cited as useful guidelines to the devising of the authors' own design methodology and procedures.

Chapter Three is devoted to the review of methodologies, in which the concept of methodology is explained and the systems approach is chosen as the scientific method for this project. Models, as an important and inseparable component of systems approach are classified, and characteristics are identified. The basic methods to assist the construction of descriptive, mathematical and hybrid models are described and discussed. The previous studies on networking are reviewed. And finally, special attentions are given to Determination of Performance Criteria and Measures, and Cost-effective-benefit Analysis.

Part Two: Prologue of the Study

This part consists of the following two chapters:

1. Chapter Four: Methodology applied to the Study
2. Chapter Five: General Overview on Library and Information Systems in China

In *Chapter Four*, objectives and decision problems of this project are identified. Suitable methodology and procedures of investigation, analysis and design are determined. Two useful devices, i.e. top-bottom flow and two-level hierarchical planning, are worked out to assist the design and planning. The important issues are categorised into two groups: quantitative and non-quantitative. The methods and approaches dealing with each issues under the two broad groups are discussed, and signposts are given to indicate the chapters dedicated to these issues.

Investigation and analysis are carried out before the practice of design and planning. Both the present situations of the overall totality, i.e. China's library and information systems, and its branch, i.e. agricultural library and information systems are examined. Critical overview, with special reference to the situation of networking are given. The potential of networking in China is explored. And types of potential nodes and users' groups are identified. (*Chapter Five*).

Part Three: Core of the Study

This part is divided into two, i.e. Design and Analysis of Design.

Under the design, four chapters are dedicated to the overall design and the design of Co-operative Acquisition Program (CAP), Interlibrary Loan-Union Catalogue System (ILL-UC) and Information Retrieval System (IR). And under the analysis of design, two chapters, i.e. cost-effective-benefit-analysis and data collection & validation, are devoted.

The design issues at the network system level are identified. The embodiment of the design follows the procedures devised in Chapter four. Three alternative programmes, i.e. non-computerised, semi-computerised and computerised systems, are defined and their means and resource involvement are distinguished. Based on the overall design, a brief description of ZALINET are given as a case study. (*Chapter Six*)

The design of the four major functions takes the forms of descriptive, mathematical and hybrid (logical) models. At a similar fashion, the review on the evolution of those network function are given; their definitions, and principles and design issues of their design are identified; the impacts of new technologies on them are explored; the performance criteria and measures are determined and finally descriptive, mathematical and hybrid (logical) models are constructed. (*Chapters 7-9 and Respective Appendices*)

Cost-effective analysis is applied to the determination of the cost requirement for purchase of library material network-wide (CAP). Cost-effective-benefit analysis, i.e. cost analysis and benefit assessment, is adopted to generate the alternatives. The result is derived according to the maximum benefit/cost ratio. Proposal and justification of the proposal are given. (*Chapter Ten and Respective Appendix*)

Both general and specific purposes of data collection are identified. Descriptions are given to each data collection exercises, in terms of purposes, types of data, methods, usefulness and results. Discussions are given to both quantitative and qualitative data. And one of the major purposes, i.e. the estimation of parameters is discussed, separately. The barriers of data collection in Chinese circumstances are presented. And finally, statistical analyses for certain types of data are described. (*Chapter Eleven and Respective Appendices*)

The salient points and important issues of the preceding eleven chapters are reviewed and summarised. And an attempt is made to synthesise some separate issues after the review of each individual chapters. (*Chapter Twelve*)

Part Four: Epilogue of the Study

Discussions and conclusions are made to some important issues. Recommendations for further research are made. And recommendations and proposals are made to 1) urge the related authorities and potential participating libraries and information centres to be prepared and 2) to facilitate the implementation of this project. (*Chapter Thirteen and Fourteen*)

Part I

Theoretical Considerations

Chapter 1

Co-operation, Resource-sharing Networks, and Networking—Some General Considerations

1.1 Definitions

1.1.1 Co-operation

What do we actually mean by co-operation? If we look in the dictionary, we find that co-operation can mean

1. "working together to the same end", or
2. the "reciprocally beneficial sharing of resources, developed or pre-existing, by two or more bodies"

Therefore, library co-operation, in simple terms, implies that two or more libraries are working together to accomplish what they cannot do, or cannot do as well, separately. In other words, co-operation among libraries can be defined as working together to benefit participating libraries. This term is the broadest of the three terms librarians often use synonymously.

1.1.2 Resource-sharing

It denotes "a mode of operation whereby functions are shared in common by a number of organisations." (Kent, 1977).

Resource-sharing is a facet of co-operation and gives libraries a chance to share not only books and other materials but also staff, cataloguing, book processing and numerous other services.

1.1.3 Networking

Networking is generally a much more structured type of co-operation in which definite regions or areas, or definite organisation are connected by electronic or other means to promote interlibrary loaning of materials, in-services training and other sharing of resources. (Smith & Parker, 1984)

Because the interpretation of these terms used varies from person to person and from area to area, it is easier to consider library co-operation, resource sharing and networking as "generic" and mostly synonymous.

1.1.4 Network

A general definition of a network might be

1. "An interconnected or interrelated chain, group or system attempting to achieve some specified common and mutually beneficial objectives." (Farber, 1972, p36)
2. "A form of arrangement or an administrative structure that links a group of individual or organisations who have agreed to work together and/or share resources." (PEPS-UNESCO, p10)

A network can be viewed as a physical network and as a logical network. The physical network is the concern of those who must operate it so that it will support the logical network. The physical network is concerned with physical channels of communications, equipment, physical interconnection of network nodes (levels), speed of processing data, file structures, etc. The logical network is the concern of those who must use the network in attempting to meet the objectives established by each network member. The logical network is function-oriented in that those who use the network think of performing a function of the logical relationship among network nodes, data files, data elements, etc. The logical structure of a network may or may not have any resemblance to its physical structure. (J.G. William, 1978)

1.1.5 Library Networks

The US National Commission on Library and Information Science (NCLIS) offers this definition of a library network, which covers a broad range of services, organisation types, and modes of communications:

> "Two or more libraries and/or other organisations engaged in a common pattern of information exchange, through communications, for some function purpose. A network usually consists of a formal arrangement whereby materials, information, and services provided by a variety of libraries and/or other organisations are made available to all potential users." (NCLIS, 1975, pp82-83)

1. Co-operation, Resource-sharing Networks, and Networking—Some General Considerations

Butler's (1975) definition of a library network includes the following components:

1. **A dependent system** which operates multilaterally "in concert" in response to the common desires of a group of member libraries, as opposed to various shared or co-operative services which are offered unilaterally to libraries of all types by vendors or other libraries;
2. **A duplex element** which enables two-way communication, which separates a network from a publication, or an information services which is one-way;
3. **Digital** which excludes various multi-library functions that fulfil other characteristics but do not involve some use of computers, telecommunications or digital manipulation;
4. The **Distribution of Information** which may take the forms of catalogue cards, print-outs, CRT displays, micro-images etc.
5. An **independent organisation** separates from the administrative, political and fiscal bounds of its members.

In this thesis, the focus is put on the organisational network. While physical network is not the major concern though the network may involve some digital manipulation. Furthermore, under Chinese circumstances, it is difficult for a network to be independent. Therefore, only components 1), 2) and 4) will be applied to the network modelled by the author.

Stevens (1981) states his criteria for a library network

1. *Geographical Level*: state, multistate, or national;
2. *Financial Support*: primarily from payments for services from participating libraries;
3. *Direction*: having a full-time, specialised staff;
4. *Governance*: by an independent body, including a high level of involvement by members usually through a board of directors or trustees; and
5. *Service*: use of a large-scale co-operative database in machine-readable form available online via a telecommunication network.

Markuson (1976) has distinguished three levels of library co-operative activities:

1. Library Co-operation — any activity between two or more libraries to facilitate, promote, and enhance library operation, use of resources and services to users.
2. Library Consortia — a specialised type of co-operative library activity usually restricted to a limited geographical area, number of libraries, type of library, or subject interest and having some degree of formalisation of administration and procedures.
3. Library Network — a specialised type of library operation for centralising development of co-operative programs and services, including the use of computers and telecommunications, and requiring, the establishment of a central office and a staff to accomplish network programs rather than merely co-ordinate them.

1.1.6 Information Network

UNESCO suggested the following definition:

> "Information network entails the sharing of resources so that the information needs of both actual and potential users of information — from the local to national level — of all network participants are met."(PEPS-UNESCO, p11)

Swank (1970) defines an information network as having these characteristics:

1. *Information Resources* — collection of documents or data in whatever medium; the database; the input;
2. *Readers or Users* — usually remote from the main sources of information;
3. *Schemes for Intellectual Organisation of Documents or Data* — as directories for use by readers or users.
4. *Methods for the Delivery of Resource to readers or Users* — the output;
5. *Formal Organisation* — of co-operating or contracting formations, representing different databases and/or groups of users;
6. *Bi-directional Communication Networks* — preferably through high-speed, long distance electrical signal transmission with switching capability and computer hook-ups.

1.2 Classifying Networks

Reviewing the papers published about previous studies, one finds a bewildering array of networks and many ways of classifying them. Networks are perceived from many points of view such as (King, 1978):

1. By the signals they carry; e.g. digital network
2. By their logical structure; e.g. star or centralised network
3. By their institutional focus; e.g. academic library network
4. By the functions they perform; e.g. interlibrary loan network
5. By the subjects they treat; e.g. agricultural information network
6. By the equipment they employ; e.g. computer network
7. By the geographic area they encompass; e.g. regional network

A network may also be described based on one or more of the following criteria:

1. By type of Organisational functions

   Some network consist primarily of libraries, while others are mainly composed of information or data centres. Networks can also consist of a combination of functions, like those of a documentation centre cum library; an integrated data, information and library network under the same supreme authority or under different but co-operating authorities; or an independent data centre network and independent library network under the guidance of different governmental offices.

2. By content or specialised purposes

   For instance, agriculture is such a multi-disciplinary subject that various sub-networks can be created for each of these disciplines. In addition to an agriculture network in general, sub-networks can also be established to focus on specific subjects and serve specific groups.

3. By structure or configuration

   Network configuration or organisational hierarchy is an important specification because it affects the communication channels and the flow pattern of messages.

Reflecting from the above discussion, the network being modelled, therefore, has the following components:

1. *Nodes*: Agricultural libraries and information centres;
2. *Links*: Different means of communication
3. *Configuration*: Hierarchical or other forms, in terms of organisation;
4. *Institutional focus*: Multitype;
5. *Subject*: Agriculture;
6. *Geographic Area*: Regional (provincial); and
7. *Functions*: Multi-functional.

1.3 Distinction of Computer Network, Communication Network and Information Network

As has been noted earlier, there appears to be considerable overlap in uses of the term network. The following definitions can help us to distinguish between three types, i.e. computer, communication and information etc.

1. Computer network (Neumann, 1974)

> "Computer network is an interconnection of assemblies of computer systems, terminals and communication facilities."

2. Communication Network (Federal Communication Commission, 1973)

> "Communication Network consists of transmission lines, concentrators, switching mechanisms, and non-data-processing functional components."

3. Information Network (Becker and Olson, 1968)

> "Information Network, in its broadest sense, can be any situation in which more than two participants are engaged in common pattern of information exchange through communication for some functional purpose."

1.4 Three major factors of a Library Network

As Kent (1978) proposed, resource-sharing networks currently in operation or in planning can be categorised in terms of three factors:

1. Types (configurations) of Network
2. Types of Sources Material
3. Operations (Functions) performed

If these three factors are displayed in three dimensions (Figure 1.1), it is possible to depict a structure in terms of specific operations performed by specific network types for given types of source materials. Thus, a *star network* (I), which offers bibliographic access (3) to books and monographs (B) would be characterised symbolically as I.3.B. For example, the Research Library Group (RLG) would be characterised as II.3.A., since it is working toward a *distributed network* (II) for libraries with initial emphasis on bibliographic access (3) and on serials (A).

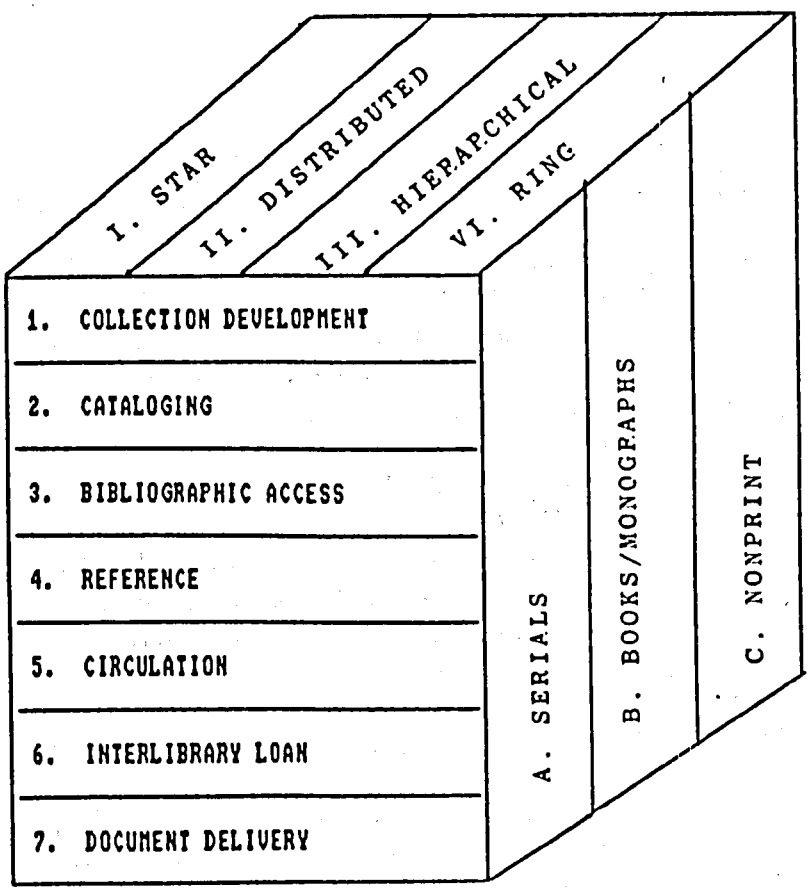
1.5 Configuration of Network

No matter what type of network it is, a network is a collection of nodes joined together by communication linksfor the purpose of sharing a work load or one more resources.

Nodes: they are loci of information, input, output, storage, processing, organisation, control and use. They may be libraries, information centres, users, publishing houses and abstracting and indexing services. (Becker, 1971, p284)

Links (Arcs): they are channels of communication that bridge all nodes and through which information may pass from node to node.

Figure 1.1: Three Dimensions of a Library Network



Network Configuration: they are the patterns that result from the connection of nodes and arcs.

Whether networks are computerised or not, they are configurated in a number of traditional ways. Among the most common configurations are

1. star networks (centralised)
2. ring networks (cyclic)
3. hierarchical networks
4. decentralised networks (distributed)

   Some derived forms:
5. two regular networks
6. composite centralised networks

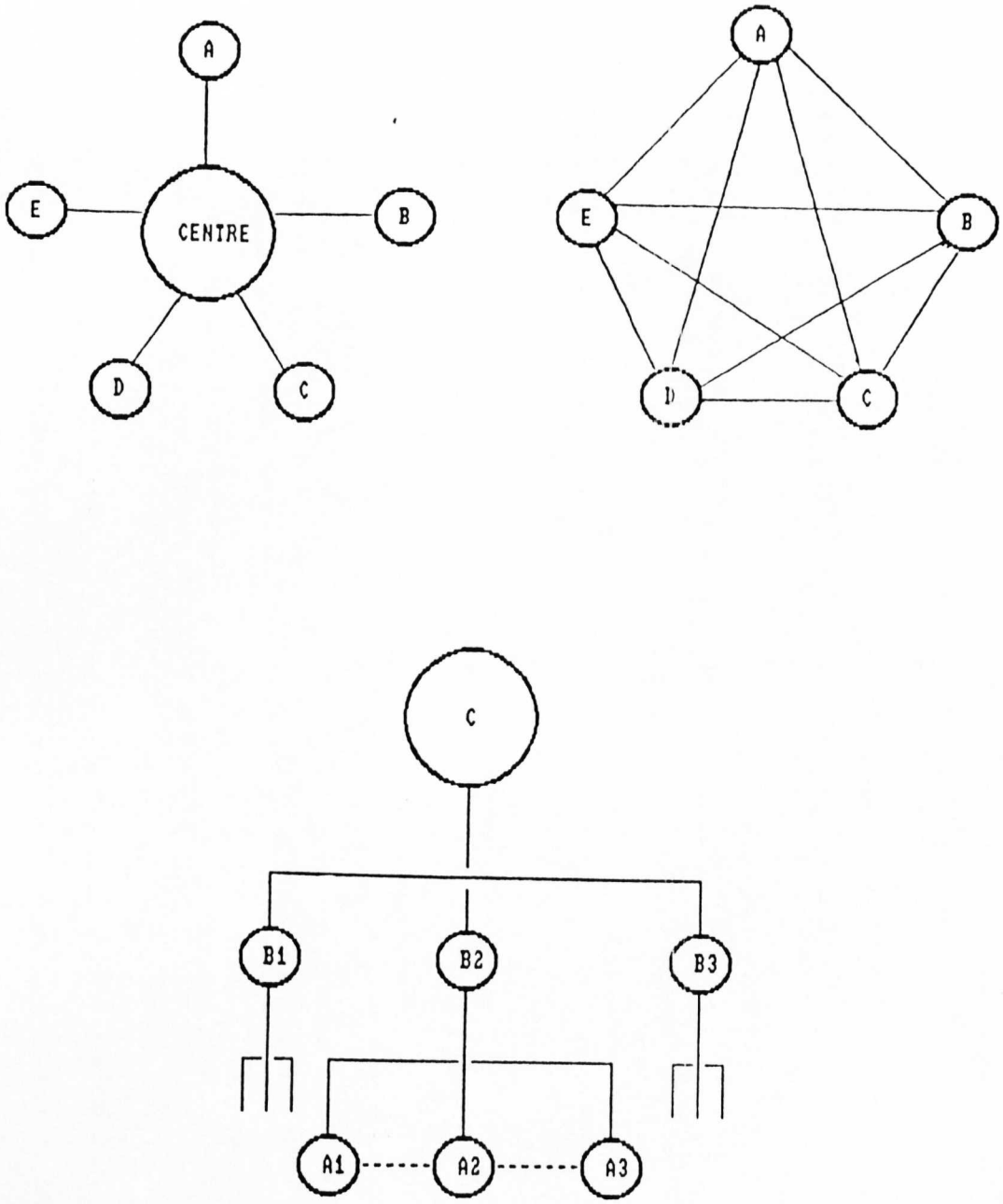
The three main types of configuration can be illustrated in a graphic form(Figure 1.2)

A centralised network entails one network member holding substantially all resources, with all other members utilising these resources. Centralised networks provide access to the central node by one arc joining each outer node. In terms of management control, the centralised configuration can be characterised by a vertical flow of information with centralised control. The central node is distinguished by the ability to communicate with every other node. The most effective way to implement change in this type of network is for management to control the input and output flow at the central node. The specific day-to-day administration of the nodes in the outer ring is left to local administrators. Consider a situation where a certain budget is allocated by the network management to support collection development in the outer nodes. A network with centralised control over the budget can use such funding as an incentive to improve overall network services through co-operative collection programmes, for example among member libraries. Thus one can see that policies generated by a centralised management can motivate improvement of overall network services rather than improving local resources only as might be the case if individual libraries solely made decision.

In a cyclic network, there is precisely one arc leading from each node to another. These arcs are so chosen that the entire configuration forms one cycle or loop, with no repeated arcs or nodes. In such a network, most network members usually hold almost equal resources. One example can be seen in an interlibrary loan network without location information, in which the route policy is usually relaying the request to the nearest libraries until satisfied. In this case, the turn-around time is very much dependent on the relay times, which is decided by the ability of nodes in satisfying the specific request. One characteristic shared by both the cyclic and the decentralised network is the absence of a natural head or main library.

A hierarchical network entails members sharing resources locally; passing dissatisfied needs along to the next greater resource centre. And a hierarchical network provides, as does the cyclic network, a single path from any node to any other; hence, relatively long response time

Figure 1.2: Network Configurations



or turn-around time might be expected. But since it is organised as a branching tree, the hierarchical network provides for relatively simple monitoring and control of information flow and transaction (Williams & Flynn, 1978).

A decentralised or distributed network is composed of members with equal, but different resources, with all members able to call directly on the resources of all other members. And a decentralised network provides immediate access from each node to every other one by an arc joining each pair of nodes.

There are examples of each type of network in existence. OCLC would be classified as a totally centralised network, RLG (Research Library Group) as a decentralised network, the Suburban Library System in Illinois as a distributed centralised, and the National Library of Medicine (NLM) as a hierarchical network.

But upon closer examination, few, if any, networks are of pure type. In fact, many of the library and information networks tend to have a variety of configurations in one system. They may be centralised in one aspect and decentralised, hierarchical or mixed in another. To gain high efficiency in the networks, the configuration, in terms of information flow will usually be rather complicated and it must be a mixed one. Information, thus, can be transferred horizontally and vertically. For instance, OCLC is centralised in the physical sense but not in terms of how it is utilised by libraries. Some libraries utilise OCLC as a part of distributed centralised libraries. That is, an OCLC node is also a central node for another network. In such a structure the central node in the library network queries and captures data from OCLC, that is, makesit available to its nodes for circulation, bibliographic access, etc.

1.6 The Impetus for information Networking

Generally speaking, the reasons for networking are all due to the recognition of two serious threats to library users and national information needs. One is the recognition that no single library can be wholly self-sufficient in the faces of demands for a broad spectrum of bibliographic requirements in support of research needs; the other is the impossibility of funding either from governmental or from non-governmental source a multitude of libraries duplicating a good deal of their efforts. The latter "threat" in particular has special importance for developing countries. In those countries, because of the low level of industrialisation and the consequent lack of public funds for the implementation of educational and social policies, a very careful choice must be made when allocating financial resources to a large number of socially desirable and economically compelling programmes.

The impetus for library and information networking can be analysed in more detail by the following aspects:

1.6.1 Growth of the Knowledge Record

Exponential growth and rapid fragmentation have characterised the universe of recorded knowledge for the past century. The volume of book and journal production both in English and other languages has continued to increase rapidly year after year. UNESCO's statistics of world book production indicate that between 1955 and 1972, the number of titles published annually in all countries nearly doubled, from a world total of 285,000 titles to an annual outpouring of 561,000 book titles from the world's presses.

Equally significant is the phenomenon commonly termed "Balkanization of knowledge", that is, the rapid fragmentation of established disciplines into new subfields, each of which immediately spawns a new monograph and journal literature of its own. This new body of recorded information adds to, rather than substitutes for, any of the existing literature. Finally, established definitions of subject boundaries of library collections continue to break down with the growth of interdisciplinary, mission-oriented instruction and research while whole new metadisciplines have emerged. These cut across the range of traditional fields of investigation and attack the basic structure of departmental libraries and specialised subject collections.

This kind of growth and complexity in the character of knowledge records severely diminishes the capability of any library to provide from its own collections those materials likely to be requested by its users.

1.6.2 Rising of User Expectations (Demand)

The simple arithmetic of the growth of book and journal publishing, then, turns the once appealing dream of institutional self-sufficiency into a nightmarish struggle to reach an ever-receding island of safety and rest. At the same time, librarian have been increasingly assailed by the rising tide of users expectations.

Library users have not only grown articulately and vocally in their demand on scarce book and journal resources, but also have come to expect considerably more rapid response time from agencies that meet human informational needs. There is still another kind of force that has a major impact on the response capabilities of libraries, that is modern technology.

Growth and fragmentation of conventional printed knowledge records, rising user expectation, and alternatives to print in storing and transmitting data, all have exerted their influence in altering the character both traditional measures of library effectiveness and traditional philosophical bases of library service. These and other developments in the large social environment have forced a basic change from a "material-orientation" to a "user-orientation". The shift has. in turn, been of fundamental importance in the development of a climate receptive to the growth of newer concepts of pooled collections and library resources sharing as an increasingly attractive to exclusive local ownership of books and journals (Galvin & Murphy, 1978).

1.6.3 Rising of Costs in the Collection of Information

The costs of library services alone have been on the upswing in the recent years. The high rates of books and audio-visual materials hinder libraries from maintaining comprehensive collections.

As it is to be expected, almost every library has a finite budget for acquisitions. Libraries therefore tend to limit their purchases to cover materials which comprise the core collection for the subject concerned, plus others that are in constant demand by local users. Budgetary constraints amidst rising costs call attention to the usefulness of co-operative arrangements in sustaining regular services and acquisition activities, and providing new ones as costs are spread over many co-operating libraries.

A library which does not adopt some kind of resource-sharing will eventually decrease the volume of published information that it can cover and handle within its limited means, resulting in dissatisfaction and frustration of its users.

Therefore, fiscal pressure have forced a search for alternatives to local ownership and institutional self-sufficiency.

1.6.4 Technological Imperatives

Along with financial pressures, the development of "new technology" and its widespread availability in support of networking is a very significant factor in the current growth of resource sharing activities. The technologies, here, refer to computers, micrographics, telecommunications and audio-visual media.

In the area of library processing, access to computerised bibliographical files has made the long-time dream of shared cataloguing and union listing a national reality. Furthermore, regional acquisition, circulation and interlibrary loan systems, are rapidly becoming feasible in the context of a national system. In subject retrieval, at least half a dozen international on-line systems provide access to bibliographical databases through a variety of public and private agencies.

1.7 Objectives of Networks

The general objectives of resource sharing networks, have been identified by Kent in 1976, — to provide a positive net effect:

1. on the library user in terms of access to more material or services; and or
2. on the library budget in terms of providing level service at less cost, increased service at level cost, or much more services at less cost than if undertake individually.

It is noticeable that many possible objectives can be identified for specific networks. However, these objectives should be realised without harm to the mission of participating libraries, although their methods of operation in variably must be adjusted. Similarly, the objectives are realisable only with some changes in the habits of users. The activities involved in realising the objectives are

1. Sharing of the burden of purchasing materials;
2. Sharing of the burden of processing the materials;
3. Sharing of services; and
4. Sharing of human expertise.

The means for conducting these activities entails increasingly the use of technology: computers and/or telecommunications.

Montgomery (1976) believes that it is difficult to assess how far towards the realisation of the objectives mentioned above any of the current library networks has come. He suggests a general model for a library network. It offers a number of objectives that are easily adapted to specific, measurable service goals for use by any network. From a consideration of this general model and the two goals mentioned at the outset (more services for the same cost or the same services for less cost), a number of objectives can be proposed. The library network must

1. Provide library service to at least as many users via the network as were served by each individual library prior to the network. That is, use of a library network should not result in a net loss of local users for any of the individual libraries. Any library network should be sensitive to this possibility. Hopefully, of course, such a measurement will show a net increase in library users for each library in the network.
2. Fulfil at least as many requests for library materials via the network as were met by each individual library prior to the network. That is, library services to the patron communities should not diminish as a result of a library network.
3. Provide bibliographic access to library network book and journal resources at least as rapidly as conventional location devices such as local card catalogues do. That is, bibliographic access should not diminish as a result of a library network. Ideally, such measurement will show a decrease in bibliographic access time for most searches.
4. Offer access to a larger collection of material than is available at any one of the libraries in the network;
5. Provide delivery of library materials borrowed via the network within a specific amount of time in a majority of network loans. That is, the library patron may not be served well by a network that library provides bibliographic access in seconds if actual delivery of the material takes an inordinate amount of time.

1.8 Network Functions

As we are aware of, networks currently perform an array of functions involving numerous activities, a variety of technological methods, a diversity of human expertise, and a plethora of problems. Generally speaking, network functions fall into three primary classes (Williams & Flynn, 1978), i.e. those that

1. Serve the patron directly;
2. Serve the member libraries directly and the patron indirectly, and
3. Support the network structure

The first two general function types might be termed goal-oriented. They attempt to fulfil the primary goal of the network (services to the patron) and its necessary conditions. The third general type, functions that support network activities, is "means-oriented". It consists of activities that contribute to the accomplishment of the other two primary goals. For example, the function that serve the patron directly would include:

1. Interlibrary Loan, with its reliance on photocopying and delivery of material;
2. Inter-system reference, with its reliance on a communication subsystem;
3. Inter-system referral, with its reliance on a file of resource and communications system; and
4. Continuing Education, whether for professionals within the network, or for patrons in general.

Those that serve the library interests directly and patron indirectly would include:

1. Co-operative acquisition programmes;
2. The technical processing involved in acquisitions;
3. Cataloguing and other means of resource identification and location, and item Circulation control systems.

And functions that support the network activities might involve:

1. The creation and operation of systems that implement the functions mentioned above (systems support);
2. Evaluation activities, such as the collection of statistics, analysis of performance, and user evaluation studies;

3. Staff and user training activities;
4. The determination of costs and setting of fees;
5. Communications activities such as publication, the holding of meetings, etc.

Keeping in mind that library functions do not exist in isolation but are related to each other, it is important for any attempt at networking to consider not only the individual function the libraries decide to perform, but also the relationships among each of the functions libraries perform. The Pitt (Williams & Flynn, 1978) survey of networks revealed that networks perform many functions that might not be obvious at first glance. The functions range from the very common interlibrary loan to the less common functions of serving as clearinghouse for materials. In the initial list of functions performed, the following were the most frequently mentioned:

a. interlibrary loan
b. reference
c. delivery
d. acquisitions
e. union lists
f. continuing education
g. bibliographic access
h. photocopying
i. circulation
j. communication
k. publications
l. cataloguing
m. processing
n. storage
o. literature searching
p. collections development
q. abstracting/indexing
r. referral
s. consulting
t. accounting & management
v. microfilming

The details of the major functions which the network is going to perform will be discussed in Chapter Six.

1.9 Barriers to Networking

Nolting (1969) categories the following barriers to networking:

Psychological

1. Fear of loss of autonomy.
2. Clash of personalities.
3. Jealousy and Stubbornness.
4. Complacency and self-satisfaction.
5. Mistrust between libraries.

6. Inertia and indifference.
7. Unwillingness to experiment.
8. Assumption that each library has unique rather than commonplace needs.

Lack of Information and Experience

1. Lack of knowledge of needs of users.
2. Lack of information about the true functions of different types of libraries.
3. Unpredictability of demands on the library by its legitimate users.
4. Failure to inform the public on library collections and services.
5. Failure of small libraries to realise the value of resources of larger libraries.

Traditional and Historical Barriers

1. Fear by large libraries of being over-used and undercompensated.
2. Institutional competition between school and public libraries.
3. Inadequacy of libraries to serve their own needs.
4. Conflict between the boards of public libraries and those of private libraries.
5. Limitations on access to academic and special libraries.
6. Thinking of only one type of co-operation.
7. Reluctance of independent libraries to relinquish any responsibilities.

Physical and Geographical Barriers

1. Distance between libraries and distance of users from the library.
2. Difference in size of library collections.
3. Difficulty of providing service to sparsely settled rural areas.
4. Lack of space in public library to serve students.
5. Delays in satisfying needs and requests of users.
6. Overemphasis by librarians on housekeeping activities.

All of these barriers are not focused in every phase of network development. Besides, as the development of electronic network, some additional barriers have appeared. For instance, there has been a fear of displacement by high technologies from librarians and others.

Table 1.1: Governance Structure Category

	[a]	Policy Approved by	Incentive
1.	Government	Government Agency	Political/Service
2.	Quasi-Government	Government	Political/Service
3.	Membership	Membership	Service
4.	For-profit	Organisation	Service/Profit
5.	Non-profit	Organisation	Service
6.	Network Suppliers	Suppliers	Service/Profit

[a] Adopted from Stevens (1977)

1.10 Governance of Networks

Mathews (1978) believes that governance is the set of processing through which an organisation confirms its goals, establishes policy, selects its leaders, and insures the necessary resources to carry out its purposes. Selection of leaders is likely to be the most important role of governance, while insuring resources usually involves budgetary decisions and fund raising. Governance might be carried out simply by a board of directors acting in accordance with by-laws. But frequently with committees formed, for example, to handle policy in areas of finance, planning, operations, and so forth. Presumably each committee is related in an intelligent way to the governing board, the governance process carried forward through the harmonious action of the governance structure as a whole.

Governance in the context of library networks is the sum of the relationships between participants and their institutions and the network organisations.

The purposes of governance are to provide a mechanism for identifying goals and objectives of the library network; for the establishment of policies by which the library will operate and for the resolution of conflict. In particular, governance is also the mechanism for overcoming the barriers to networking. In a broader sense, the purpose of governance is to provide a mechanism for overcoming the barriers to any "new" organisations such as a library network.

Stevens (1977) divides library network governance into three categories: governance by government; governance under a quasi-governmental body; and governance by the membership under a legal charter and by-laws. To these categories, Montgomery added three more: governance by a for-profit organisation; governance by a not-for-profit organisation; and governance by a network supplier organisation.

The governance structure adopted may vary depending on the category selected. Unfortunately, the formulae for choosing among these structures are not yet developed. The principal differences among these categories involve the organisational environment and its relationship with member libraries are expressed by policies and in the incentive for co-operation. Table 1.1 attempts to link governance structure with policy approval body and the incentive for making the library network work.

1. Co-operation, Resource-sharing Networks, and Networking—Some General Considerations

The above general consideration of the state-of-the-art of networking should provide some theoretical bases for the practices of design and planning an complex system like a network.

Chapter 2

Design and Planning of Information System

2.1 Introduction

What is known empirically about system design? Firstly, it occurs as part of what is usually called the overall system development cycle. In discussing this cycle most researchers distinguish five or more phases, beginning with an existing system to be investigated and analysed, and culminating in a new system that in turn may lead to the beginning of another new cycle. In a broad sense, overall system development cycle includes investigation, analysis, design and implementation. (Wyllys, 1979)

The cycle is not linear but iterative. The first two phases identify the desired functions of the new system. The design phase follows the analysis phase, although the two phases can overlap. In the implementation, the design is translated into reality and the whole process is concluded.

The author intends to emphasise ... the design of library and information system. If we follow the cycle, the design of a new system is an activity that follows the investigation and analysis of the existing information system. However, the two processes—information systems analysis and design—often overlap each other in actual practice.

In the art of information systems design there is no generally accepted procedure. If a designer of information systems has a methodology, it is often a private one, and it is not necessarily consistently applied. (Liston & Schoene, 1971)

But there is one cardinal principle that must be borne in mind from the very beginning. An information system is more likely to be accepted and adopted by a user community if the community has been actively involved in the design of the system from the very beginning. (Lancaster, 1979)

2.2 Concepts

2.2.1 System

System is defined in Webster's Seventh New Collegiate Dictionary as "a regularly interacting or interdependent group of items forming a unified whole". Similarly, Vickery (1973) gives the following definition:

> "In the broadest sense, a system is a set of interacting components. The components can be entities or processes. An entity can be a person, group, institution or thing." (p21)

Churchman (1971) lists the five essential aspects of a system as:

1. The objectives of the system and the performance measures which surrogate the objectives;
2. The environment of the system—the set of fixed constraints which limit the behaviour of the system and are not under the direct control of the system's managers;
3. The resources of the system—the money, personnel, and equipment available to the system;
4. The components of the system—the operations and functions performed in each of its sub-systems; and
5. The management of the system etc.

The above aspects consist of non-quantitative and quantitative issues which need different tools to cope with.

2.2.2 Environment

Everything outside a system is its environment.

> "The environment is the set of all entities, a change in whose attributes affects the system, and also those entities whose attributes are changed by the behaviour of the system." (McMillan, 1973, p2).

2.2.3 Information System

Liston and Schoene (1971) define information systems broadly as "any systems which handle information of any kind".

Vickery (1973) believes that an information system can be viewed 1) as a system of interlinked entities (languages, symbols, signals, information items, articles, publications, guides, libraries and so on), and 2) as a system of interlinked processes (encoding, transmitting, transforming, writing, publishing, translating, abstracting, lending, searching, reading, and so on).

2.2.4 System Analysis

Fasana (1973) defines system analysis as a body of techniques and doctrine which is:

> "concerned with systematically analysing a total system in context and in identifying and describing the interrelatedness of all the component parts of operations of the overall system." (p465).

2.2.5 System Design

System design may be viewed as a series of choice in which the designer selects each of the various items or elements of the system.

In the following sections, the author will emphasise on system design and planning. However, as mentioned above, system analysis and design phases overlap.

2.3 System Design

Here the author is to quote several people's discussion of system design and aims at using them as a guideline in the practice of the design and planning in this project.

2.3.1 Vickery's Description

Following Vickery's (1973) definition, we can diagram a system as

Then system design appears to be straightforward: decide on the outputs required from available inputs, analyse the processes necessary to get from one to the other, investigate

alternative procedures by which each process can be carried out, and choose those which do an effective job at acceptable cost.

There is a whole set of actions and reactions between man, tool, work and environment. A good system design tries to foresee all interactions, and to avoid unwanted ones. Simply because systems are complex, they cannot be designed by rule of thumb. In any but the most well-tested situations, system design is an art, with choices often based on subjective values.

The whole systems development process can be pictured as follows:

1. Definition of the system to be defined, in terms of objectives;
2. Collection, analysis and interpretation of data relevant to this system;
3. Overall design of a system, with estimates of its technical, economic and operational feasibility;
4. Detailed design and costing;
5. Realisation of the design by practical implementation; and
6. Evaluation of the implemented system in term of objectives.

Although the main steps can be set out sequentially, the process is highly iterative: both analysis and overall design may lead to modification of the system definition, design work will show up the need for further data, implementation will reveal defects in design, and evaluation may lead to drastic rethinking of the whole.

The Analysis Phase

The first important point is of course to get clear what it is that must be designed. This is not a trivial question-it involves exploring with system managers and users what are their underlying aims and needs.

A set of question can be asked at this stage, such as what are the functions of the system to be designed or redesigned? What is the general environment of the defined system? What kind of services outputs should the system have?

In answering these sets of questions, it is particularly important to consider the wider systems of which the defined system is a part. The designer should envisage all the possible uses of the files that may be created, in the hope that they can be made flexible enough to serve all these uses, or as many as is feasible.

The early phases of analysis should concentrate on gaining as wide a view as possible of the proposed system and its environment. Factors at first unrecognised are thus brought to light, that may significantly affect design decisions. As analysis proceeds, tentative design options will be formulated, and these will suggest where the analysis needs to go into further detail.

It is wise not to embark on detailed analysis or surveys until a clear need for specific data is formulated—much time can be spent collecting data that proves irrelevant.

Information systems analysis needs techniques such as various kinds of charting, work measurement, costing, survey and so on. The designer must know when and how to apply his techniques, but above all he needs insight, and an appreciation of the complexity of information transfer.

Overall Design

On the completion of the analysis phase, the objectives, definition and environment of an information system will have been established, together with unavoidable constraints and technical possibilities. Overall design has the following tasks:

1. To decide on the output services to be provided, and on the inputs from which they will be derived.
2. To determine the functional steps leading from inputs to outputs.
3. If data processing equipment is involved, to allocate functions as between man and machine.
4. To assess the technical, operational and economic feasibility of the proposed design.

There is no rule of thumb by which one can get from the data provided by analysis to the functional diagram that outlines a system design. It is at this stage-choosing the components of a system and weaving them into a configuration-that the designer must exercise his imaginative insight into the whole complex situation that his analysis has revealed. He must appreciate user needs, technical possibilities, and constraints including costs.

2.3.2 Optner's Definition

Optner defines a system as a "device for examining the process of problem solving, and he lists the following as steps to be used in solving problems" (read "designing systems"):

1. The problem process must be flow-charted, showing the principal decision points;
2. Details of the principal decision process steps must be described;
3. The principal alternatives and how they were generated must be demonstrable;
4. The assumptions pertinent to each alternative must be identified;
5. The criteria by which each alternative will be judged must be fully stated;

6. Detailed presentation of data, data relationships, and the procedural steps by which data were evaluated must be part of any solution; and
7. The major alternative solutions, and details to explain why other solutions were eliminated, must be shown.

2.3.3 Kent's List

Kent (1966) lists the following factors that are to be considered in designing and evaluating systems:

1. Objectives: The overall purpose of the system;
2. Functions: Major classes of actions or performance required to achieve the objectives;
3. Performance requirements: Specific dimensions of required actions, with a statement of the standard or required level of performance for each; and
4. Environmental variable: Properties of the environment that affect the system and its performance.

2.3.4 Hayes's Summary

Clearly, in a complex system, effectiveness is not a single measure, such as cost or speed, but is a complex function of many attributes. In summing up the principles of systems analysis, Hayes (1966) writes:

> "The one thing characterising the entire process—from definition to design to evaluation—is repetition and modification. As a result of the analysis, new requirements will be defined and objectives changed. Some desires are not feasible and must be reduced, and the attempt to define alternative solutions will reveal analysis gaps. So the steps outlined above [problem definition, selection of objectives, analysis, definition of alternative solutions, evaluation, iteration, and re-iteration] do not represent a simple sequence, but rather a complex, iterative, dynamic process. The result [of the analysis] is a system design including a complete description or 'documentation' and a plan for implementation and conversion and with sufficient flexibility to accommodate later changes." (p12)

2.3.5 Borko's Reflection

Borko (1967) believes that there is a growing recognition that designers of information systems need to rely on information scientists to provide the theories and tools that are basic to the design process.

In essence, information science provides the scientific basis and the tools that are used by the systems analyst to design information systems. System analysis is a formal procedure for examining a complex process or organisation, reducing it to its component parts, and relating these parts to each other and to the unit as a whole in accordance with an agreed-upon performance criterion. System design is a synthesising procedure for combining resources into a new pattern.

Systems analysis is often viewed as being essentially a problem-solving process; the resulting design is the solution to the problem.

2.3.6 UNESCO's Guideline

Karen (1976) prepared "Guidelines on the Planning of National Scientific and Technological Information Systems" for UNESCO. In the guidelines, a logical sequence of the planning operations were proposed as follows:

1. A thorough study of the requirements and aims of the convening authority.
2. A review and evaluation of previous reports and documents which relate to the project.
3. A study of the basic policy considerations of the system of which the proposed information activity forms part.
4. Any plan needs to take full cognizance of the existing infrastructure.
5. From the conduct of the survey and studies needed for a better understanding of the existing infrastructure some recommendations for immediate and operative action are likely to result.
6. At this stage, the planner should have enough background information to add another dimension to the basic long-range policy objectives he was originally given.
7. Since long-range policy objectives are not identical with short and medium term goals, the last two must be translated into a series of detailed recommendations, setting out who does what and when, how it is to be done, how performance should be measured, what standards and procedures should be applied.
8. A broad outline of the desired systems design will by now have emerged and the approximate costs for each facet must be calculated. It is also necessary to assign priorities for each of the tasks which have been set.
9. Having set forth budget requirements and implementation priorities, the planner will frequently find that policy objectives and detailed recommendations have to be revised in order to bring them in line with feasible cost figures and attainable priorities.
10. A final project report takes shape by now. This report, being essentially the planner's proposal for a systems design.

...

Three principal parameters are identified in the guideline:

1. The information user (frequently identical with the information originator).
2. The information contents (the message or intelligence).
3. Modes of supply and delivery (transfer methods).

Frequently the planner of an information system wishes to ensure that all factors pertinent to his specific systems needs have been adequately considered. "Checklists" provide a useful tool in achieving this aim, although the planner should be aware that no check-list is ever exhaustive, unambiguous and appropriate in every circumstances. The principal headings in the check-list are:

1. The rationale and objectives of information systems.
2. A general development forecast of information work (world-wide).
3. The information user.
4. The existing infrastructure.
5. The projected information scene (the systems plan).
6. Recommendations and timetable.

The above discussion are applicable in fairly general areas in information systems. Since the author's interests in this project fall into a special area of information system—network, the exploration of more specific guidelines for the network design and planning is necessary. The following section is devoted to this purposes.

2.4 Design and Planning of a Complex Information System—Network

Network is a complex information system, whose design and planning requires some systematic and complicated methodologies. There are two ways of developing networks:

1. By beginning with existing systems and services and improving their efficiency;
2. By formulating new objectives and functions for a to-be-designed system.

Usually, however, networks are built upon something.

2.4.1 Methods and Research for Design of Information Networks

In one of his article, Slamecka (1970) concerns questions of research appropriate to the design of networks of library and information services. He points out:

> "What is the range of the research areas which bear on the design of library and information networks? Table 2.1 attempts to suggest a framework for placing social, technical and administrative considerations into a functional, discipline-oriented relationship. While nearly all calls for research fall into this framework, there is less agreement on the relative value of individual areas and topics.
>
> A plan to design and implement an advanced network of library and information services is actually a statement expressing known relations and dependencies of significant component activities and process of the task. Once such a plan has been drawn up, it is relatively easy to identify what problems, if any, should or must be researched. In the absence of a plan, however, discussions of proposed or necessary research should at least outline the concept or form of the information network to which they refer; without such an outline, the question of research need and value often remains open." (p555–556)

He categorises the development of advanced networks of library and information services into two principal approaches, i.e. 1) Some existing services and system of services amounting to a transition from the present-day state of these services to a higher level. In this case, the primary goal of this development is then an improvement in the efficiency of the system processes and performance; 2) A to-be designed system beginning with a formulation of new objectives and functions, in which the designer follows a procedure which embodies rigorous elements of the scientific methods.

He believes that for systems of information services, this procedure contains the following sequence of three phases:

1. Assessment of the Market
   - Definition of Market
   - Identification of Information Uses
2. Design of Information Services
   - Standard Products
   - Special Services
3. Design of the Information System
   - Information Store
   - Process and Operations Design
   - Quality Control

Table 2.1: Research Areas Relating to Design of Networks for Library and Information Services

A. SOCIAL SCIENCE
   1. Environment
      - Functions and relations of components agencies in the network
      - Identification of new services
      - Effects on man, society, science
   2. Market
      - Identification and description
      - Information requirements and users
   3. Manpower
      - Personnel requirements and characteristics
      - Education and training
   4. Management
      - Organisation
      - Management: planning, operations, control

B. INFORMATION SCIENCE
   1. Theory of Information
      - Semiotics (syntax, semantics, pragmatics of natural and artificial languages)
      - Information processes (generation, collection, coding, organisation, transmission, transformation, storage, use)
      - Information measures
   2. Human Engineering
      - Man-machine communication
      - Man as information processor
   3. Information Processing Technology
      - Hardware design and operating characteristics
      - Software languages, systems
      - Communication Engineering
   4. Information Systems Engineering
      - Information systems properties(structure, behaviour)
      - Information systems analysis and synthesis
      - Methodologies of complex systems design evaluation
      - Economics of information systems and networks
      - Management of design and operations

In contrast, the redesign of system of services which retain their basic objectives and functions involves the second and more often, only the third phase.

Using this distinction of approach, we can conveniently identify and distinguish between design efforts which propose (and are restricted to) the improvement of efficiency of existing information services, and those which seek new objectives as the basis for their services and systems.

When reviewing the methodologies utilised in present-day ongoing designs of library and information networks, Slamecka found that apparently they are primarily concerned with redesign of systems of existing services. While these redesign efforts frequently entail an upgrading of some parameters of existing services (e.g. speed, comprehensiveness and so on), the consideration of new services and especially of new markets is conspicuously absent from ongoing activities in library and information networking.

It is true that the currently attempted and planned networking activities in the library and information professions have their goal to introduce greater efficiencies in the existing and assumed functions of bibliographic control and services. These efficiencies are to be derived through the sharing or networking of various selected processes and of data in existing systems. The emerging networks will thus provide for centralised bibliographic recording-keeping on a geographic and/or subject basis; co-operative acquisition and technical processing of materials; co-operative, co-ordinated production of various types of bibliographic aids; and optionally, for a capability of decentralised inquiry against compatible record files. While efficiency improvement of existing library and information services can be a desirable goal by itself, it is apparent that in accepting the objectives and premises of these services, the current networking designs are not concerned with fundamentally new approaches to improve the effectiveness of information communication in society.

...

Slamecka then classifies the methods being used to induce efficiency into two types: technical and organisational. He points out:

> "The technical approach rests primarily in the mechanisation of physical processes and their elements; the organisational methods employs co-ordination, co-operation, and partial centralisation. To the extent that the success of the current efforts at networking of services will be reflected by the efficiencies attained, the necessary or desirable research can be expected to relate principally to these two methods." (p555–556)

A category of desirable research concerns questions of political and organisational nature. It is clear that major efficiencies in the existing library and information systems can be realised at the level of co-operative networking. The types, sizes and characteristics of these networks are subject to an interplay of a variety of factors—political, economic, geographic, and human. Thoughtful analysis of the possible, desirable and permissible categories of networks

and network nodes should yield another element of the data necessary for the systematic development of a national network. He further points out that:

> "A major threat of delay to the networking of library and information services appears to be the less-than-enthusiastic attitude of the decision-making echelons of the library profession. It is improbable that this attitude can be dissolved solely by standard management techniques which apply political pressures or through financial incentives which may encourage divisiveness. We must recognise the serious social overtones inherent in this resistance to networking and mechanisation, as well as the symptom of a profession in crisis. It is perhaps here, in the area of social science research in librarianship, that a most urgent effort is vital in order to find new directions for profession in transition." (p561)

2.4.2 Network Planning

Planning is generally defined as the process by which a certain goal or objective is projected and procedures and activities are developed in order to attain it. While planning may occur within a vacuum, in practice planning generally involves changes in existing structures and relationships.

In discussing library network planning, these structures and relationships are the existing formal or informal library network.

In undertaking and planning effort, four planning elements seem to be essential: Motivation, the setting of planning process goals, the identification of key stakeholders and their involvement in planning, and the decision making process to be employed.

The establishment of a clear motivation for planning is the essential first step in the network planning process. Some form of formal or informal needs assessment may be undertaken, as may survey or studies. These may serve to articulate unmet needs, problems or limitations in existing services, or possible new directions.

The second step, the setting of planning process goals, will do much to determine the success of any network planning. Where goals are insufficiently articulated, the likelihood of confusion increases drastically-participants may suspect hidden agendas, or even attribute incorrect motivation to those initiating planning.

The third element is an identification of key stakeholders and their role in the planning process. Essentially, key stakeholders are persons or groups who have the most to win or lose from any changes in the existing structure, and whose involvement is critical if any plan is to be accepted.

The fourth element of networking planning is the decision making method to be adopted for planning purposes (Fiels & Drescher, 1987).

The discussions in the whole chapter concern high-level and general considerations about

system design and planning. In order to practise the design and planning in a real world, more specific methodologies are required. It is necessary to review the methodologies applicable to the problem areas. The next chapter is dedicated to meeting this end.

Chapter 3

Review of Methodologies

3.1 Introduction

An efficient and effective approach to expand knowledge is the conduct of special, planned, and structured investigations—a process known as research. The term scientific method serves as a descriptor for an investigative approach in which the objective of the inquirer is to achieve precise and reliable knowledge. This is not to imply that only one research methodology is appropriate, however; rather, the term scientific method is used to characterise many effective techniques of inquiry (Bush & Harter, 1980).

Therefore, the term methodology refers to the way in which we approach problems, and seek answers. The term applies to how one conduct research. Our assumptions, interests, and purposes shape which methodology we choose.

Checkland (1981) mentioned that Kotarbinski distinguishes three current conceptions of methodology, which he calls praxiological—"the science of ...ways of expert procedures", logical—"the study of methods of using one's mind", and epistemo-logical—"the study of sciences as historical products and processes". His own sense of the word is that the outcome of the research is not a method but a set of principles of methods which in any particular situation have to be reduced to a method uniquely suitable to that particular situation.

The design of the methodology is the core of research. It should be based on the following 1) knowledge of basic research methods; 2) careful literature search-a thorough familiarity with current literature relevant to facets of the problem; 3) recognition of the stated problem etc.

This chapter is dedicated to review 1) concepts of system approaches and models (descriptive, OR and logical models in particular), 2) basic research methods and 3) the methodologies applied in some previous studies relevant to library and information world, and library and information networks more closely.

3.2 Systems Approach

As defined in the preceding chapter, overall system development follows five or more phases, beginning with an existing system to be analysed and culminating in a new system that in turn may lead to the beginning of another new cycle. The scientific method, here referring to the "systems approach", is basically the establishment of models (sometimes more abstractly called hypotheses) which must have two properties: First, they must account for all known facts, and secondly, they must enable us to make predictions which may be tested by any unbiased and independent observer. ... Once established by fitting known facts and tested by making predictions for which there are independent observational data, the model is used for experimentation, by which the results of various ways of running the business may be determined. To sum up, the "systems approach" usually takes the stages of data collecting, model building, prediction and validation. Prediction and validation lead to more data gathering.

Therefore, the "systems approach" is both a philosophy and a body of analytical techniques by means of which an analyst attempts to consider all aspects of a system.

The research methods can then be classified in a number of ways: Firstly, they can be divided into two broad types: which approach non-quantitative and quantitative issues and which help construct descriptive or mathematical models. Secondly, they can be grouped into the ones which are applied in different types of researches, experimental or survey or historical or operations research etc. And thirdly, they can be categorised according to different phases in a system development cycle. Fourthly, they can be characterised according to the applications at different stages. But it is noteworthy that methods applied in different types of research or different phases of system development or different stages of systems approach can cope with both non-quantitative and quantitative issues and help the construction of both descriptive and mathematical models. In other words, the different types of methods are not mutually exclusive.

3.2.1 System Analysis, System Design and Models

Description of systems and explanation of system behaviour, and design of system are the purposes of the systems approach.

Systems analysis, system design and model building are inseparable notions. To describe and design a system means that we construct some kind of representation or model of it. As we shall note, the media the model builder uses range from the physical to the symbolic. A model is the analyst's description of the system. In other words, a model is an abstract representation of real phenomena that exist externally to our thinking processes. (Alexander, 1974)

3.2.2 Classification of models

Batty (1977) classifies the models according to different criteria:

1. Non-optimising models
   Behavioural and descriptive models
2. Optimising models
   Predictive and Normative models
3. Solution Procedure
   Analytical Models and Simulation Models
4. Comprehensiveness
   General Models and Partial Models

Alexander (1974) presents a model classification in which system models are organised according to their degree of abstraction:

1. Verbal Models
2. Schematic Models
   including Static System Models, Flow Systems Models and Dynamic System Models
3. Iconic Models
4. Analog Models
5. Mathematical Models

Based on the reflection from the above classifications, the author tries to emphasis on two distinguished types of models, i.e. descriptive models and operations research (or mathematical). Comparing the two classifications mentioned above, descriptive models may be the hybrid models between verbal and schematic models, while mathematical models may be analytical, or predictive and so on.

Descriptive models may constitute a loose category of models that rely on words or drawings to describe the elements and the interrelations of a particular system. Using words to define objects, things, events, and processes is both the most ancient and the most common approach to model building. The advantages of verbal models including their low cost, ease of construction, and ready comprehensibility. They are most useful where more sophisticated approaches to the description and analysis or routine affairs cannot be economically justified. The principal difficulties encountered with verbal (descriptive) models stem from the use of words themselves. Verbal descriptions of phenomena, in spite of our most exhaustive efforts, lack of precision. Ambiguities and semantic difficulties are frequently present in verbal communication. The verbal model is an extensively used communication device but presents difficulties in transmitting systems information when it is used alone. While representing systems in pictorial form avoids many of the communication difficulties inherent in the use of verbal models. At the same time, it presents the systemic elements and principal interrelations directly and forcefully, with a minimum of ambiguity. As a result, the use of schematic models greatly improves the efficiency of thought transfer and the effectiveness of the perception process.

Verbal models tend to be almost completely descriptive and explanatory in nature. Schematic models are also strongly descriptive. The most frequent use of schematic models is to describe complex systems in summary form. Typically, schematic models are drawings or charts that present systemic elements or their attributes together with a single relation.

Mathematical or symbolic models represent the highest level of abstraction in systemic model construction. Several barriers that constrain verbal and schematic and other models are breached by mathematical models that enable their users to extend their applications substantially. The fields of operations research and management science are devoted exclusively to developing and using mathematical models to provide management more and better information for decision making. Therefore, the combination of verbal and schematic models can avoid ambiguity to a certain degree.

Mathematical models offer a degree of precision that is limited only by our ability to count or measure. Mathematical relations may be stated in exact terms. Many systemic ones may not be accurately quantified, however, because of inadequate measurement techniques. In these cases, qualitative evaluations of the systemic relations must suffice.

Therefore, constructing models to portray the various natures of systems is a very important part of the abstraction process. Reality is usually far too complex for man to assimilate a multitude of details, organise his thoughts, and make intelligent decisions without using abstractions. The development of models to help us conceptualise the many systems in our universe provides a means for intelligently grappling with reality. Through the use of models we may perceive systemic relations, postulate systems performance or behaviour, and exercise some degree of control on our environment. (Alexander, 1974)

The different types of models are not mutually exclusive and hybrid models may also be found. A type of hybrid models in this research may be referred to logical model, which represents the soft data stemmed from mathematical models and hard data derived from descriptive models.

3.3 Basic Research Methods

In the preceding sections, the author grouped the system elements into non-quantitative and quantitative issues, and also identified the different types of models, of which descriptive and mathematical and some hybrid models are of major interest. Based on those identifications, we may make such a rough division that descriptive models describe and explain non-quantitative issues; mathematical models cope with quantitative issues while hybrid models are concerned with hard data derived from qualitative issues and soft data derived from quantitative issues.

In the systems approach, the design of procedures and methods by which the identified problems will be studied is essential. There are usually varieties of methods applicable to the problem areas. Among them are:

1. Survey

- Questionnaires
- Interviews

2. Historical Research
3. Observation and Description
4. The Case Study Method
5. Comparative Studies
6. Delphi Methods
7. Documentary Research
8. Statistical Analysis
9. Mathematical Modelling (Operations Research)
10. Simulation

Here, the author intends to review some of the above methods.

3.3.1 Survey Methods

Survey research is characterised by the selection of random samples from large and small populations to obtain empirical knowledge of a contemporary nature. This knowledge allows generalisation to be made about the characteristics, opinions, beliefs, attitudes, and so on, of the entire population being studied.

Survey research methods are used to obtain three broad classes of data: (a) information about incidents and developments (data about events in a given period); (b) information about distributions and frequencies (data concerning the possessions or characteristics of each member of a subject group); and (c) information about generally known rules and statuses (data about institutional norms and conditions) (Busha & Harter, 1980).

Questionnaires are often used in surveys as the primary data-collection instruments.

As the purpose of surveys is to acquire current-rather than historical-information about such factors as their experiences and opinions of people, the interview also serves as a useful survey tool.

3.3.2 Observation and Description

In field studies, direct observation and ensuing description of phenomena are used to better understand situations, processes, developments, events, or some other phenomenon. The

act of describing also involves the preparation of factual reports about observed phenomena, including—insofar as possible—an account of relationships noticed among variables. Research data for many descriptive studies are comprised of newly generated information, rather than pre-recorded data. Studies in which a phenomenon will be characterised over a lengthy time period usually rely upon historical records or documents. In both descriptive and purely historical studies, however, investigators do not manipulate variables. Moreover, controlled conditions are not used to initiate the occurrence of a desired event.

In descriptive studies based upon direct observation, capable investigators are prudent to avoid the mere accumulation of facts. To be meaningful and fruitful, the observation undertaken in descriptive research must be followed by a synthesis, analysis, or interpretation of the collected data. In descriptive studies, the process of observation normally takes precedence over that of evaluation. Moreover generalisations are not made unless representative observations have been selected from samples of defined populations (Busha & Harter, 1980).

Bias is a major problem related to observation and description. Thus research workers must subdue their natural tendency to selectively view phenomena that tend to support personal conceptions, presumptions, and prejudices.

3.3.3 Case Study

The case study is particularly appropriate for a single research object and attempts in gathering extensive data about it so that relationships among variables associated with the observed phenomenon can be identified. This approach allows a concentrated focus on a single phenomenon and the utilisation of a wide array of data- gathering methods. The overall purpose of a case study is to obtain comprehensive information about the research object. Data-gathering methods used in case studies are based primarily upon direct observation; both participant and non-participant observation can be used. When necessary, these methods are supplemented by structured techniques such as interviews and questionnaires.

3.3.4 Comparative Studies

Collings (1971) defines comparative librarianship as

> "the systematic analysis of library development, practices, or problems as they occur under different circumstances (most usually in different countries)- considered in the context of the relevant historical, geographical, political, economic, social, cultural, and other determinant background factors found in the situations under study." (p492)

Most comparative studies in librarianship have encompassed comparisons of practices and study of library science in nations and regions of the world; they have focus on such topics as education for librarianship, political control of libraries, library resources and services,

publishing in relation to libraries, patterns of communication, cross-cultural influences in librarianship, and other related topics.

3.3.5 Delphi Methods

Comprised of a group of modified survey procedures, the Delphi method is designed for use in refining judgmental data collected from a panel of selected experts (Busha & Harter, 1980).

3.3.6 Statistical Techniques

Statistical Techniques are those that utilise empirical data to compare or predict based on at least two events, processing or attributes.

In the process of conducting research, librarians compile and collect many different types of numerical data. Although some of these data originate from the recorded observation of daily routine library operations, others are generated in the form of responses to various questionnaires, tests, and other instruments that have been devised to obtain information regarding library phenomena. Knowledge of the techniques of quantitative analysis can aid librarians in making correct interpretations of these data.

Purpose of Use of Statistics and Statistical Methodology

The use of statistics can allow librarians to obtain the maximum amount of information from their research efforts. Using statistical methodology the librarian can test hypotheses; compute means and other measures of central tendency; assess the relationship between one variable and another; make predictions; determine the reliability and validity of instruments and measurements; generalise conclusions from sample data to populations; present research data in graphical and tabular formats; calculate the variability of research data; determine the significance of the difference between the performance of two groups; and much more.

Techniques of Statistical Analysis

The techniques of statistical analysis can be summarised as follows:

1. Descriptive Statistics
2. Frequency Distributions
3. Inferential Statistics

Descriptive statistics consists of methods and procedures for summarising, simplifying, reducing, and presenting raw data, to communicate the essence of the data to another. The purpose of such methods is essentially reportorial while inferential methods are used to make predictions, to test hypotheses, and to infer characteristics of a population from characteristics of a sample The latter includes analysis of variance, Chi-square test and regression etc. (Busha & Harter, 1980)

3.3.7 Mathematical Models (Operations Research)

Definition and Concepts of OR

Operations research is the use of scientific methods to study the functions of an organisation so as to develop better methods of planning and controlling changes in the organisation. It can be viewed as a branch of management, engineering, or science. (Elton & Vickery, 1973)

OR has the following three basic essential characteristics:

1. It is a problem-solving activity;
2. It proceeds using the scientific method—that is, the formulation, testing and refinement of models of reality;
3. It uses models to estimate consequence of alternative courses of action towards some ends, so that one with the most preferred consequence can be identified and implemented.

The key emphasis is on the construction, testing and manipulation of symbolic models to aid decision-making.

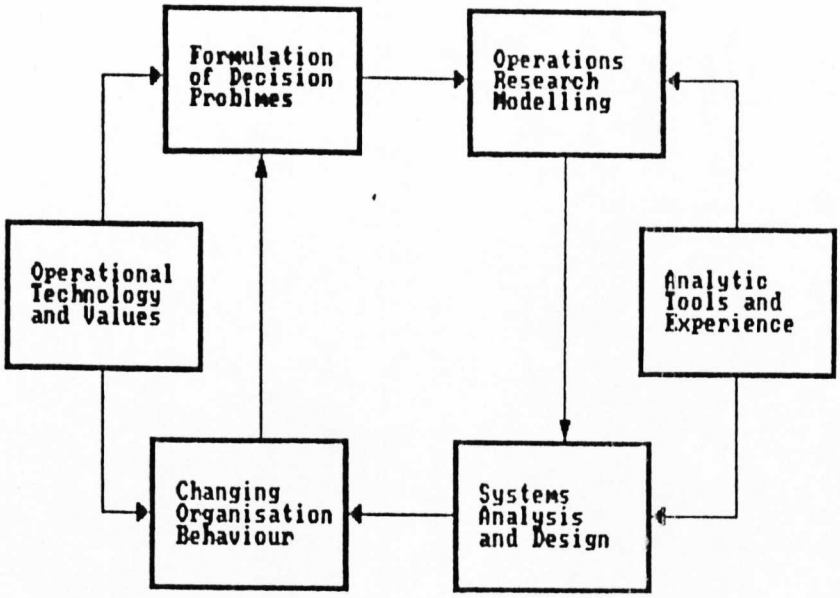
Operations Research Process

Leimkuhler (1977) points out that operations research begins with the study of the people who make decisions in an organisation and seeks to make more explicit the alternatives they face and their reasons for making choices. There are four major steps: formulation of the decision problem, analysis and design of a system for solving the problem, and incorporation of the system in the organisation. The total process is a cyclical one. The four step process shown in Figure 3.1. is augmented by the available analytical tools and experience of other researchers in many different areas of application.

Importance of Model-Building in OR

An OR model, in its most general terms may be represented as

Figure 3.1: The Process of OR[1]



$$P = f(c, u)$$

The performance (P) of a system, relative to its objectives, is a function of its variable attributes—both those under the control of decision maker (c), and those not under his control(u). Manipulating the model is a matter of demonstrating how P will change as c is altered and as u changes. To formulate a model, it is necessary: (1) to identify the relevant variables c and u and the range of values that each take, (2) to construct a valid operational P, and (3) to determine the form of the functions (f) (Elton & Vickery, 1973).

Model-building is the essence of the operations research approach. Constructing a model helps you put the complexities and possible uncertainties attending a decision-making problem into a logical framework amenable to comprehensive analysis. Such a model clarifies the decision alternatives and their anticipated effects, indicates the data that are relevant for analysing the alternatives, and leads to informative conclusions. In short, the model is a vehicle for arriving at a well- structured view of reality.

In operations research, a model is almost always a mathematical, and necessarily an approximate, representation of reality. It must be formulated to capture the crux of the decision-making problem. At the same time, it must be sufficiently free of burdensome minor detail to lend itself to finding an improved solution that is capable of implementation.

Techniques of operations research

The conventional techniques of operations research modelling can be listed as follows:

1. Decision Theory: Utility Function, Game Theory
2. Resource Allocation: Linear, Integer, non-linear Programming optimisation, Search Theory, Classical Techniques
3. Graph Theory: Networks, PERT/CPM
4. Queuing Theory: Stochastic Processes
5. Simulation
6. Problem-Solving: Heuristics, Cybernetics, Artificial Intelligence
7. Mathematics: Statistical Analysis, Probability, Time Series Analysis, Economic Analysis
8. Behavioural Science

3.3.8 Simulation

Simulation combines statistical techniques and mathematical models that build a model of an entire system or subject using statistical probability distribution for generating and controlling transactions but also utilising analytical techniques to compute the values of certain variables.

3.3.9 System Analysis and OR

In his article, Leimkuhler (1977) separates operations research and systems analysis as two interchangeably, analytical techniques: they represent the theoretical and applied sides of the same field. He states that both are seriously deficient when taken to be only theory or only application and what is needed is a good blending of the two.

In this project, the author uses systems analysis, or "systems approach" in it broadest sense, as a whole methodology which covers descriptive modelling for non-quantitative issues and mathematical modelling for quantitative issues in investigation, analysis and design phases of the system development cycle.

When reviewing the applications, it is convenient that we refer descriptive model building to non-quantitative approaches and mathematical modelling to quantitative approaches.

3.4 Review of the Applications

As we may have noticed, among the general categories of studies on networks are the descriptive or comparative studies, feasibility tests, determination of performance measures, economic or cost analysis, and the modelling and simulation.

The review will emphasis on the applications by the non-quantitative (descriptive), quantitative (OR) and other approaches.

3.4.1 Non-quantitative Approaches

Definition

The phrase non-quantitative methodology here refers in the broadest sense to the research that produces descriptive data: people's own written or spoken word and observable behaviour. Non-quantitative methodology, like quantitative methodology, is more than a set of data gathering techniques. It is a way of approaching the empirical world.

Methods applicable

The construction of descriptive models can be based on methods like survey, historical research, observation and description etc.

Areas in which the Approaches are applicable

Non-quantitative methodology is suitable to solve the problems which fall into social, behavioural, psychological and political categories since those problems can not be quantified.

Application of Non-quantitative Approaches to Network Studies

The purposes of non-quantitative approaches to networking problem can be summarised as follows:

1. Describing and analysing the definitions, components, functions activities;
2. Assessing and evaluating the existing networks;
3. Making a comparison of various types of networks;
4. Discussing the dynamic social and political environment of networking, the administrative processes, economic aspects and technological developments; and

5. Suggesting implications for building the networks of the future, etc.

Of the various categories of methodology, descriptive and comparative studies predominate, with much effort devoted to the description of systems. Descriptions may be of total systems or of individual components of systems, and may be developed through observation or survey techniques. Several descriptive studies have addressed the use of OCLC by different groups of libraries. Each of these involved surveys, with some covering various aspects of implementation and operations under the OCLC system. (Palmour & Roderer, 1978)

A variation on the descriptive study is one in which comparisons among several libraries or systems are made. Conclusions may or may not be drawn. In this category, Casey (1974) puts forth the chronological development of network activities in several states, focusing on the "multitype" library network.

Some more examples in the category of non-quantitative Methodology can be seen: in his paper given in 1978 Conference on the "Structure & Governance of Library Networks, Kent (1976) describes and analyses the following issues: (1) Library and Network functions; (2) Single Function vs Multiple Functions; (3) Objectives; (4) Mixing Types of Clienteles, Materials and Libraries. He further presents "A case for Resource Sharing in Children's Literature by Margaret M. Kimmel". At the same conference, J.G. William & R. Flynn made some judgement and assessment on some problems related to network functions. The work was based on a survey of networks in the United States and Canada, conducted by the Office of Communication Programmes at the University of Pittsburgh. In the paper, they listed and discussed 17 most frequently mentioned functions, which were part of the functions revealed by the Pitt Survey of networks.

3.4.2 Quantitative Approaches (Mathematical Models)

The quantitative approaches here refer to operations research only and the definition of operations research has been given in a preceding part of this thesis.

Application Areas

The application areas in the information world by OR are enormous. Here, the author intends to give some examples.

I. Libraries

The history of the application of operations research to the problems of libraries is surprisingly long.

In keeping with the traditions of operations research is the work of Morse (1968), who studied library problems partly because of his genuine interest and concern in this area, and partly because the university library was a convenient and rich laboratory

for his students at M.I.T. The practical motivation on the part of library managers for operations research studies is the pressure to economise and expand activities by means of computers. O.R. is seen as the best way to conduct exploratory studies before making costly commitments for new computerised systems

II. Document Usage

Operation research models that have been developed within library settings tend to focus on the library as a document storage and retrieval centre. The majority of information in a library continue to be stored in book form.

The key model in Morse's study is one in which book usage over time can be predicted to follow a known mathematical form, settling down to a steady-state pattern after an initial period of popularity. The model is used to detect some interesting differences in the usage patterns of books in different subject fields. The model is then used to make policy recommendations for such activities as book acquisition, circulation, retirement, and storage, in the light of the data obtained in the M.I.T. Libraries.

Many other studies of the pattern of the usage of books and other materials in libraries have been made.

III. Availability

In Morse's study , the decision problems he addresses include: the amount and allocation of book and periodical budgets, the purchase of duplicate copies, the placement of books in open shelves, stacks, and reserve collections, changes in loan policies, control of losses, limitations on shelf space and the use of storage areas. The approach taken is to estimate how many users will be inconvenienced as a result of changes in retirement, duplication, circulation, reshelving, and replacement of lost books, and then to compare these various measures of effectiveness with the dollar cost of making improvements.

One of the best examples of applying this approach in a library is the study at the University of Lancaster by Buckland and others (1975). The proportion of books having various levels of demand for use was estimated using a model similar to that proposed by Morse but modified to take explicit account of multiply copies of some items.

IV. Reference Scattering

Attempts to formulate rules for the selective acquisition of library material through the use of mathematical models have been usually associated with journal collections. This seminal work in this area is that of Bradford (1948) as expressed in his "Law of Scattering". More precise formulations of the law have been made by Vickery, Brookes, and Leimkuhler, and later Wilkinson clarified their arguments.

Brookes (1970) showed how Bradford's law can be used to estimate the total number of papers that will be found if a complete search is made of the literature, as well as the total number of journals that will contain at least one relevant article.

V. Total System Models

Operations research studies of the kind described above tend to isolate individual functions in an organisation and examine them independently, to the extent possible, of other related functions. Such suboptimisation is often necessary in order to make a

rigorous analysis of the individual functions as part of a larger and more complex system. However, there is the danger that a comprehensive and balanced view of the entire system will fail to emerge from the mere accumulation of many small scale studies. For this reason, it is desirable that some early attempts are made to define the larger system within which the various subsystems operate, even though the larger models tend to be less rigorous and less immediately useful for pressing decision problems. Models of this kind for libraries are most commonly found in the schematic diagrams used for automation programs, where large areas of library activity and even entire libraries are viewed as subsystems or computerised information systems.

At Purdue University, Baker (1970) developed a behavioural model for a library based on a simplified characterisation of the objectives of three groups: users, funders, and librarian, and the various interactions of these parties in a library environment. This model revealed the need for librarian to take the initiative in creating a better understanding of the benefits and costs of the services they offer in order to offset the tendency for users to rely on previous experience and possible misconceptions, and to distort the image of the library in the eyes of the funders.

It was expected by Leimkuhler (1977) that considerably more research would be done on the economics of libraries and the supply and demand markets in which they operate, adding to the variety of scientific expertise available to operations research studies. At the same time, increased attention must be given to the social, psychological, and political aspects of libraries.

Applications to Network Studies

I. Previous Studies

Library networks offer fertile ground for contributions by developers of mathematical models. Problems in the design, development, and operation of library networks are often quite complicated and network managers often have inadequate experience and intuition in the relatively new networking domain to allow them to base decision making solely on this experience and intuition. Furthermore, library network problems often involve substantial amounts of money; thus, modelling efforts can be justified because of the magnitude of potential rewards in terms of performance improvements or cost savings (Rouse, 1979).

The application areas and examples in network studies can be summarised as follows:

1. Planning and evaluating (e.g. Rouse, 1976, ILLINET)
2. Design and evaluation (e.g. Korfhage et al., 1972)
3. Design and analysis (e.g. Nance, 1970)
4. Prediction and decision-making (e.g.Duggan, 1969)

And the techniques adopted are:

1. Linear Programming
2. Graph theory and Network Theory
3. Queueing Theory
4. Game Theory
5. Dynamic Programming
6. Simulation Model

There has been a general lack of alternative theoretical models and objective test of performance to guide the development of public library networks.

Network participants need quantitative models or decision tables to help them assess their constraints and opportunities, determine their priorities, and then choose appropriate networking and propose a decision analysis methodology for the selection of alternatives in designing networks.

A number of models have been put forth or adapted from other fields and applied to library networks. The models used run the gamut from simple pictorial representations to complex mathematical or behavioural descriptions, and have come from a variety of disciplines.

Important ground in the development of the theoretical models of networks has been undertaken by a number of researchers including Duggan and Kochen; Nance et al.; Rouse et al.; and Cohen (1980) et al..

At Southern Methodis University, a group under Nance et al. provided a mathematical look at an information network, including measure of network structure, in particular the accessibility and flexibility in message transfer; and at University of Illinois, a group under Rouse et al made a great contribution in applying mathematical approach to planning and evaluating library network, emphasising on the measure of performance of network; more recently, Cohen et al. applied more sophisticated game theory to library networks to study individual coalition etc.

Nance's model suggests how a network can provide the greatest possible benefit for the total group by providing for the optimal flow of messages from node to node in a communication transfer. His work on the design of library information networks has also used concepts developed by graph theorists.

Models of specific networks functions and their interrelation are also useful. For example, Reynold et al. developed quantitative models (Linear equations) for functions of interlibrary loan, technical services, and collection management for each of three systems configurations: the present system in the state of Washington, regional networks, and a statewide network.

Bhat (1971) et al. developed a Markovian model for total network costs associated with each of three decisions about whether to satisfy a request, reject it or refer the message to the succeeding node in the network hierarchy.

Montgomery (1976) presents a general resource sharing network model, offering a number of objectives adaptable to specific service goals. The model was used as the basis for considering the viewpoints of various network participants and identifying problems needing attention.

Mathematical models of network activities have been used by Reed (1977), W.B. Rouse (1976), and Slate. Reed describes a computer simulation conducted for the State of Washington to evaluate mail order library services. The simulation model utilised GPSS (General Purpose System Simulator) to analyse the flow of materials through a typical mail order and delivery system. Estimated costs for a number of system configurations were developed.

Extensive modelling of network operations, primarily of ILLINET, has been conducted by W.B. Rouse (1976). His model uses a distributed queueing network and has been programmed as an interactive package. Given the dimensions, parameters, and operating policies of a library network, the model will calculate such things as the probability of satisfying a request, average delay, average total and unit costs, and average processing load. It can thus be used for a number of purposes, including the analysis of the various effects of network dispersion and distribution of resources.

Theoretical work on library network design and modelling continues to appear. W. Rouse has prepared a tutorial on the mathematical modelling of library systems, in which he considers book use, resource allocation, and library networks. He reports that so far modelling can only be credited with very limited practical accomplishments although it may be gaining increased attention and use. Kang & Rouse review that applicability of forecasting methods in predicting demand for library network services, using data from ILLINET. Regression methods were appropriate for analysing ILL statistics. Interactive analysis is discussed, and Kang reports that the programs are being used regularly to provide forecasts to the Illnois State Library, which operate ILLINET.

Game theory has been used to study library networks by Cohen & Vilverberg (1980). They found that users tend to cluster into a coalition around common use of a single function, e. g., cataloguing in OCLC. The analyses were performed before the rapid expansion of network services in the past two years. The theory may help to identify constituencies within the multipurpose networks and may help to develop charging algorithms for different services and clusters of users.

Rouse, B. (1976) believes that there are two basic approaches to analysing and predicting network performance:

1. Network flow theory
2. Queueing network

Network flow theory considers the problem of allocating flows in the various branches of a network so as to maximise the total flow through the network. (Hill 1967, HU, 1969)

Alternatively, network flow theory can be used to find the shortest path through a network, where the measure of length may be time as opposed to distance. (Nance 1970, Korfhage 1972)

However, network flow theory is difficult to apply to networks where the flows are probabilistic or stochastic in nature.

In stochastic network, queues can build up in various places of the network and thus, the time required for a request to flow through the network becomes the sum of the servicing time at each processing point in the network plus the time spent waiting in queues.

II. Advantages of OR in Network Studies

Nance et al. believes that general mathematical models of networks are useful in removing ambiguity and in clarifying the logical nature of networks. He points out that a person may disagree with the definitions, assumptions and axioms about networks that are stated in a model, but if the mathematics are correct, one cannot disagree with the validity of the conclusions developed. Moreover, a model can be manipulated to reveal how it responds to various input configurations. The analyst also can attempt to enrich the model to make any improper assumptions seem more in line with reality.

Leimkuhler (1977) believed that a great advantage of modelling and system analysis is the connection it can establish between a particular problem and the current state-of-the-art.

III. Limitations and Problems in the Application of OR

It has been noticed in literature review that the peak time of research on networking by OR was in 1970's.

Bommer (1975) assessed the situation of the applications of OR models and found the reasons why operational research has failed to achieve its potential in network or library management as follows:

1. Too much attention has been devoted to the construction and solution of complex mathematical models. And the degree of model sophistication exceeds the technical capability of the organisations;
2. Too little attention has been placed on implementation aspects of operations research models;
3. Too little emphasis has been focused upon the process of OR;

4. Too little attention has been placed on the pressing strategic problems of library managers.

S. H. Rouse (1975) commented that a considerable number of mathematical models have been developed for use by library managers in analysing their operations. Examples include book-use or circulation models, resource allocation models, and library network models. However, not many models of library operations have become standard management tools. In other words, such models are infrequently used by library managers. There seems to be two reasons for this lack of implementation. First many models are of such sophistication that typical library mangers have difficulty understanding the assumptions and resulting equations. This problem can be substantially solved by developing a well documented, interactive computer program that eliminates the need for the manager to deal directly with equations. The second problem that arises when trying to implement library models is data collection. This problem is particularly constraining in situations where models should be frequently updated.

As an extreme example, one would have difficulty proving the necessity of an automated circulation system if its only purpose was to collect data for book-use models. Similarly, OCLC probably would never have been developed if its stated purpose had been to provide data on the use of their files as an interlibrary loan location tool. The circulation and cataloguing functions justified the development of these systems.

3.5 Some Special Considerations

There are several techniques which are essential and important in model building or the process of "system approach". Among the most important techniques are Determination of Performance Criteria and Measure and Cost-effective-benefit Analysis.

3.5.1 Determination of Performance Criteria and Measures

A performance measure provides a quantitative assessment of how good is the output of a system with respect to some criterion. The crucial outputs are services provided to the system users—e.g. document delivery. Intermediate outputs are those processes that contribute to a user services- e.g. document acquisition. It is important that intermediate measures should be defined in a way that reflects their relevance to overall system performance.

Measures are tools—there is little value in developing them if they will not be used. Actually performance measure for library networks should play an important role in evaluation efforts, and their use has at least been discussed in the literature. J.G. William, at the 1976 Conference on Resource Sharing in Libraries, suggested eight network factors which should be considered in establishing performance measures. They are reliability, flexibility, accessibility, availability, acceptability, efficiency, effectiveness, and quality control. At the same conference, W. B. Rouse (1977) went on to propose a single, generalised criterion, implicitly incorporating all of Williams' factors, in which the goal of a library network is defined as

the maximisation of the expected value of the probability of users' finding what they need with a short waiting time to receive the material and a long circulation time for retaining the material. W.B. Rouse feels that such a utility theory approach to performance measure is feasible.

Objectives of Measurement of Performance

The measurement of performance has several objectives:

1. To assess how well a system (or country) is doing;
2. To identify areas of weakness where improvement may be needed;
3. To aid planners in deciding between possible alternative systems at a national or regional level;
4. To assist a user (usually a library, possibly an individual) in deciding which of one or more alternatives available systems it (or he) should use for all requests or for particular types of requests;
5. To enable a library to decide which method of requesting or supply to use;
6. To enable a supplier to measure its effectiveness and efficiency.

Problem and Limitations of Performance Measures

There is no recognised objective standard by which to judge how well a system is doing, and most performance measures therefore need to be relative. Comparison should thus be possible between different systems, across countries or regions, and over time. To this end, measures need to be developed that are widely acceptable and that are used consistently. The more countries they are used in and the longer they are used the more they gain in value.

Since most measures are of necessity relative, and thus depend on comparison (with other countries, or regions or systems or periods of time), it is important that comparisons are valid. It is, for example, interesting that country A has a higher fill rate than country B; but the types of requests may differ quite widely, so that like may not be being compared with like. This could be done by taking a careful selected sample of requests and feeding them into different systems as an experiment. In practice, a reasonable approximation can be achieved by a detailed breakdown of requests and a comparison of careful matched subsets (PGI & UNISIST, 1987).

It is not too difficult to design measures which would, if applied, provide an excellent assessment of performance both in general and in particular aspects. The problem is however that such ideal measures are very unlikely to be used or indeed usable because of practical difficulties.

No performance measure, whether used in isolation or together, can give a complete picture, if only because it is never possible to apply them comprehensively and exactly. As noted above, most measures are relative, since there can be no absolute objective standard. Comparative measures often provoke as many questions as they provide indicators and the comparison is valid. It then needs to be asked why performance is worse before deciding whether to take action and what action to take.

Moreover, performance measures will often yield only part of the information needed for effective decision and action.

Measurement should be used as an aid to decision and action, never as a substitute for each. It is sometimes tempting to delay decision until rather more adequate measurement of performance can be achieved. This is suggested even though sufficient measures are available to identify major weaknesses that need to be remedied, and though information is available on the performance of other systems that suggests means of improvement. It is never possible to work on the basis of perfect information, and the question that policy and decision makers need to ask is at what point adequate information is available.

It is possible to measure performance in very sophisticated ways by means of using mathematical models or operational research. Examples of this approach can be found in Arms (1979) and Rouse (1976). They often involve subjective assumptions, they require a great deal of data to be usable in practice, and few practising librarians can actually use them.

3.5.2 Cost-effective-benefit-analysis

Introduction

From the viewpoint of the designer and evaluator, three major characteristics of an information service are of paramount interest: its effectiveness, its cost, and its benefits.

Effectiveness can be defined as the extent to which a system's goals are achieved. Cost is the expenditure of various resources in providing some services; A benefit evaluation attempts to determine how the users will benefit from an information service; A cost-effectiveness evaluation relates measure of effectiveness to measure of cost; while a cost-benefit study attempts to relate the costs of providing some service to the benefits of having the service available. Roberts (1985) identifies that there are five main types of cost studies applicable to library and information services. They are cost analysis, cost distribution and/or cost allocation studies, unit costing and timing use cost analysis, cost-effectiveness and cost-benefit studies. The five types form a hierarchy of increasing complexity and diversity of applications.

Cost Analysis

Cost analysis is the basic mode of study which provides information for the other descriptive and analytical methods. Cost analysis can be carried out and its data presented in a variety

Table 3.1: Major Categories of Costs of Library Operation

1.	Staff salaries
2.	Material costs
3.	Equipment purchase/rental
4.	Space requirements
5.	Maintenance
6.	Computer time
7.	Programming
8.	Contractor services
9.	Staff training

of ways. Cost analysis requires the measurement of resources input to the system, an understanding of the nature and type of work carried out, and especially an appreciation of the use of time by labour (through work measurement or a substitute for it). Data from cost analysis can be fed into accounting, budgeting and performance measurement procedures.

A cost analysis must first of all identify the categories and components of input, throughput and output. This has to be done irrespective of the scale of costing exercise. For planning purposes, it is useful to compare the total costs of different possible systems. For the system designer and manager, the activities need to be compared.

When comparing the activities between different systems, a more careful analysis of the activities must be undertaken, so that like is compared with like. When one is costing some activities, a problem may arise in handling the costs of necessary preceding processes. The implication is that when one is preparing a notional costing of a planned system, one often cannot estimate the costs of the different subsystems and simply add them together, unless one treat the activity as a separate subsystem. One has to define all the elements of the proposed system and view them as a connected whole. Before examining the use of costing model in developing the possible costs involved in implementing a new system, one should look at the practical use of crude costing of an existing application.

Table 3.1 summaries and lists the major categories under which costs need to be considered.

Cost Distribution and/or Cost Allocation Studies

Cost distribution and/or cost allocation studies (the terms are often used interchangeably) look at resource allocations, flows of resources and activities, especially in the throughput or transfer stage. These are useful descriptive procedures, providing a general view of the costs carried in different parts of the library system. These analyses help to understand the outcome of previous resource allocation and financial decisions, and corrections can be applied through the estimating and budgeting process.

Unit Costing and Timing Uses Cost Analysis

Unit Costing and timing uses cost analysis data with measures of output to give cost/time indices; these are often used as performance measures. As a summarising measurement technique, unit costing and timing is attractive to managers, but it must be used with discretion, because of the sensitivity of unit cost to volume, the problems of relating variable to fixed costs, and the difficulties of the treatment of overheads. It is unwise and misleading to use unit costs as the exclusive indicator of performance.

Cost-Effectiveness Analysis

Cost-effectiveness studies are used for performance appraisal, planning and decision. Cost of existing processes and model cost data for alternative options under consideration are required and obtained through cost analysis or cost estimation. Cost-effectiveness studies are system orientated: which of several methods performs best according to the effectiveness criteria specified, and does so at a given level of costs.

Cost-effectiveness is concerned with finding the cheapest means of accomplishing a defined objective or getting the most value from a given expenditure, but a cost benefit analysis is concerned with the value of the objective itself, which will be discussed later.

There are usually three distinct (and sometimes conflicting) sets of objectives, depending on the point of view from which the assessment is to be made. These sets are the objectives of the system sponsors, those of the system designer and system users. In the ideal case, one would like to have a careful statement of the desired goals. In practice, however, one usually settles for an as-quick-as-possible goal statement and establishes a list of agree-on criteria for measurement.

It is obviously easier to perform a cost-effectiveness study of a subsystem, which will be or has been designed to perform only one or two functions, than it is to look at a large system that has several different objectives. When more than one criteria of performance is involved, there are inevitable trade-offs between the criteria, which implies that there must be some subjective weighting of the criteria relative to each other or that considerations of relative benefit or value must be made.

Cost-Benefit Analysis

Roberts (1985) defines cost-benefit analysis as

> " a technique which attempts to set out and evaluate the social costs and social benefits of investment projects to help decide whether or not a project should be undertaken." (p130)

Cost-benefit analysis is a systematic comparison between the cost of carrying out a service or activity and the value of that service or activity, quantified as far as possible; all costs and benefits (direct and indirect, financial and social) being taken into account. It involves the listing and consideration of as many effects as can be identified—beneficial and adverse, short-term and long-term, tangible and intangible—on all persons and groups likely to be affected by a proposed project or service. The value of this appraisal depends on how completely all effects can be traced and the extent to which they can be evaluated in comparable (usually monetary) terms.

A formal benefit analysis would attempt to assign actual values, generally in monetary terms, to each item, although one must realise the difficulty of assigning a monetary value to things such as "greater convenience and legibility of book-form printout as compared with a card-file.

Cost-benefit studies, in the proper sense, are rarely carried out for library and information service provision. Yet, the appropriateness of cost-benefit analysis for the appraisal of major investment is obvious, especially when public goods and services are concerned and welfare considerations of social cost and social benefit uppermost. Cost-benefit studies draw on cost data from the other four types of cost study.

To compare alternatives in a cost/benefit analysis, five possible methods are available to make this comparison. They are:

1. Maximise benefits for a given cost;
2. Minimise costs for a given level of benefits;
3. Maximise the ratio of benefits over costs;
4. Maximise the net benefits (present value of benefits minus present value of costs); and
5. Maximise the internal rate of return on the investment.

Notice that the criteria, "Maximise benefits for minimum costs," is a contradiction and has no value in a cost/benefit analysis.

The choice of the most appropriate cost/benefit analysis method depends upon the situation.

Applications

Robertson (1970) el at. worked out a standard costing for information systems. They pointed out that one might postulate two possible ways of arriving at comparative costs for the analysis of information systems, namely:

1. General survey methods: the overall costs of a large number of information systems are broken down into a small number of categories, and analysed for correlation.

2. In-depth Study: a small number of systems are studied in detail in an attempt to establish the true sources of the costs and factors affecting them.

Cohen (1977) used an economic model to explore the costs and benefits of book use. He focused on resource sharing and offered an equation for analysing its cost. His paper included a detailed breakdown of book costs for the Hillman Library for 1974-1975.

Pitt & Kraft (1974) developed a library operations research model to assist in budget allocation for acquisition and photocopying.

The utility of random sampling coupled with self-reporting was demonstrated by Spence (1971) in a study of ILL and photocopying services in a regional medical library. Random alarm devices were issued to staff members working on the function under study, together with a short recording form. Spencer included a detailed discussion of how the random alarm devices were used and noted that the methodology did provide low cost, reliable data with minimal interruption to library operations.

Robertson et al. (1973) developed a set of task categories that were used to develop operation-oriented diaries.

Many good cost studies are available to guide those who are planning such studies. There is also a good "how to" literature to help those who are planning their first study. The problem is the application of these tools. There is virtually no standard. Studies at the operational/functional levels have focused on individual situations, with little thought to reliability and external validity. The lack of movement toward standardisation and improvement of methodologies and models is disappointing. Leimkuhler & Cooper (1971), Robertson et al. (1970), and Price (1974) all proposed some standard methodologies. But we see little indication that they are being used, much less improved.

The purposes of the review of methodologies are obvious: to seek for a philosophy and a body of techniques and means by which the author can fulfil the ultimate objective of this project, i.e. the design and planning of an agricultural library and information network suited to Chinese circumstances. The next chapter will discuss the decision about methodology and particular methods for particular issues.

Part II

Prologue of the Study

Chapter 4

Methodology Applied to the Study

4.1 Introduction

As reviewed in the preceding chapter, network studies can apply a number of methodologies. But which will be the best for this research? Before any decision about the methodology is made, it is important to clarify the purposes and objectives of the project. In the introduction, the purposes and objectives of this project have been identified as follows:

1. To work out an agricultural library and information network model suited to China's circumstances for the purpose of design and planning (focusing on provincial scale);
2. To seek the methodologies best adaptable to the problem areas;
3. To propose the future development of agricultural library and information network in China; and
4. To urge the importance of networking etc.

The above purposes and objectives lead to the following decision problems in this project:

1. What is the most *cost-effective-benefit network model* suited to Chinese circumstances?
2. What *functions* should the network perform?
3. Is the choice of the *four conventional co-operative activities* (CA, ILL, UC and IR chosen by the author) a correct one?
4. In what *modes* (three alternative programmes)? And with what *structures* and *policies* those four services will be provided?

The decision problems involve many trade-offs, including trade-offs 1) between the individual co-operative activities (network functions); 2) between those individual functions and overall

network function; 3) between nodes; 4) between nodes and network, 5) between users and network, in terms of cost, effectiveness and benefits, and 6) between costs and different levels of effectiveness.

By examining the objectives and decision problems of this project, it is obvious that the "systems approach" is an appropriate methodology to fulfil the objectives and to solve the problems. The core problems fall into three phases of the system development cycle, i.e. investigation, analysis and design, which involve data-gathering, modelling (both descriptive and mathematical), and prediction. The issues in the decision problems are either non-quantitative or quantitative. Therefore, both descriptive and mathematical models are desirable, and hybrid (logical) models may also be needed to cope with the hard data from descriptive models and soft data from mathematical models. In other words, to analyse and design such a complex library and information system, both non-quantitative and quantitative approaches are needed. The embodiment of such a philosophy takes the form of descriptive models and mathematical models and some kind of hybrid models in the design of each individual function.

As mentioned earlier, the design of research procedures and methods by which the identified problems will be studied is essential. In the following sections, an attempt will be made to describe the procedures of design, and to indicate the particular issues and the related methods.

4.2 Design and Planning

4.2.1 Overall Design Procedures

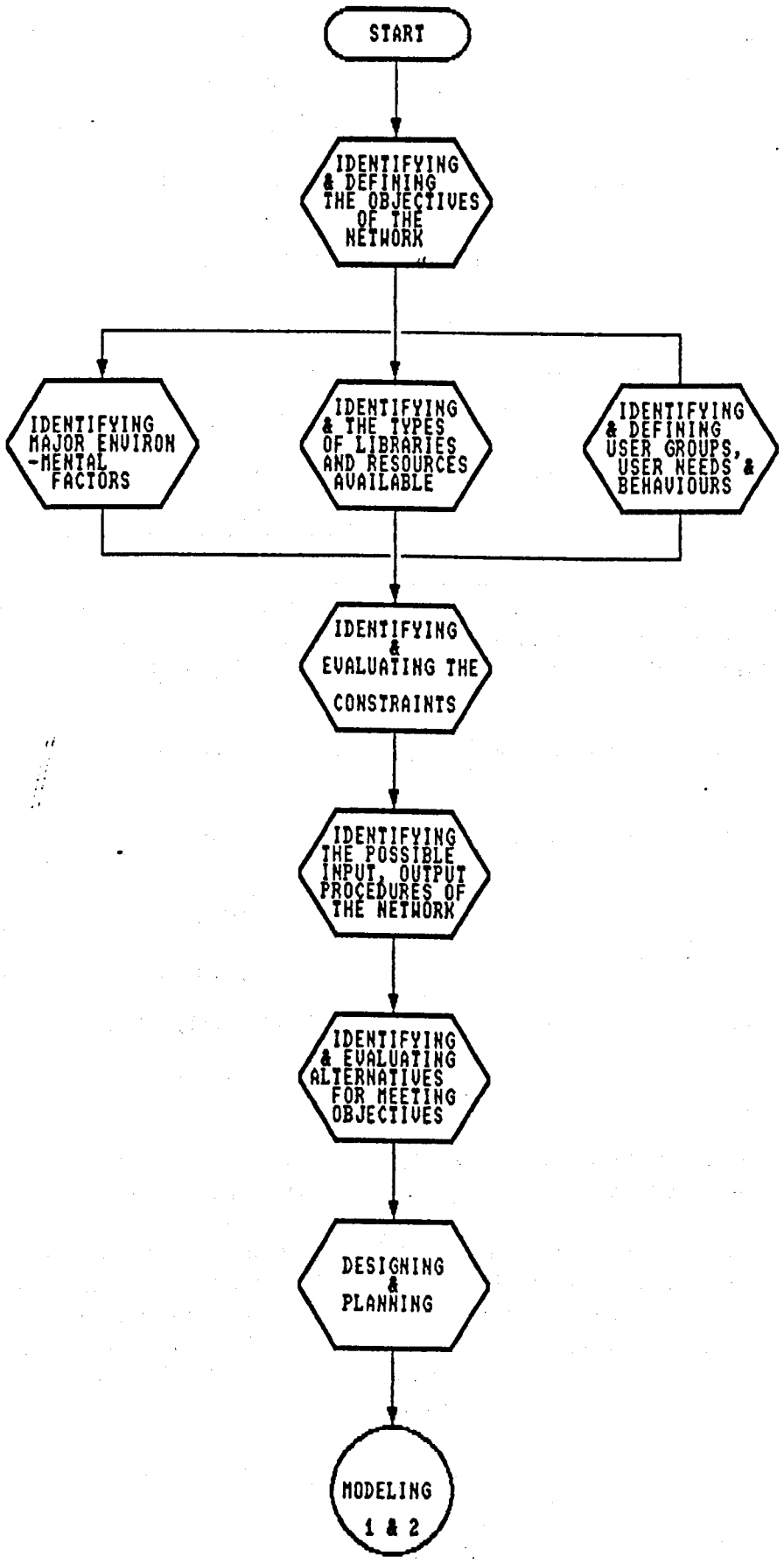
The very first step for any system design is to work out some detailed design and planning procedures. Thus the design can be carried out systematically. Based on the analysis of 1) the basic design and planning procedures, 2) the characteristics of network design and planning, and 3) the decision problems in the project, the author can decide her own design and planning procedures for this project. The procedures have been flowcharted to indicate the logic, sequences and relationship of these procedures. (Figure 4.1)

Examining Figure 4.1, we can find that the procedures suit both types of approaches, i.e. Non-quantitative Approaches—Descriptive Models and Quantitative Approaches—Operations Research Models. The detailed explanation of those procedures will be given in a later section and the embodiment of those procedures can be found in Chapter Six, Seven, Eight and Nine.

4.2.2 Identification of Issues and Approaches in the Design and Planning

Here, the author intends to identify both non-quantitative and quantitative issues in the design and Planning.

Figure 4.1: Overall Design Procedures



In this project, descriptive model building referred to the category of non-quantitative approaches is adopted:

1. To describe and evaluate agricultural library and information systems in China;
2. To determine the configuration of the network;
3. To identify the objectives, major environmental factors, resources of the network being designed;
4. To identify the nodes and the links of the network;
5. To identify the potential users, user groups and their information needs and behaviour;
6. To define performance criteria and performance measures for quantitative approaches;
7. To identify the constraints in literal terms;
8. To identify the input, output and procedures of the network etc; and
9. To assess network benefits qualitatively.

The methods of operations research and statistical analysis, referred to the category of quantitative approaches, are applied to the design and analysis of cost-effective-benefit network models. More precisely, the OR models are concerned with the following solutions:

1. Optimal resource allocation—optimal coverage, distribution and duplication of collection for CA;
2. Minimum cost, minimum turn-around time and maximum probability of satisfaction for ILL;
3. Cost-effectiveness of UC;
4. Cost-effectiveness of IR;
5. Cost-effective-benefit trade-off between individual functions and overall network; and
6. Cost-benefit Analysis of three alternative programmes.

Detailed cost analysis and benefit assessment are needed in order to make the cost-effective-benefit comparisons between alternative programmes, which will be defined in Chapter Six.

The data including request data, costs data and some background data were collected by survey methods. And they are tested and processed by statistical analysis and cost analysis 1) to seek the conformity with the empirical assumptions, 2) to help set objective measures, 3) to estimate parameters and co-efficiency, 4) to derive some mean, average and unit values, and 5) to test some hypotheses.

To sum up, the cost-effective-benefits of the services as an overall criteria, and cost-effective-benefit analysis as an processing tool, help determine 1) What are the best *models* for Chinese Agricultural Library and Information Network?— by both descriptive analysis and modelling; 2) Which *programme* will be run in the network, computerised or non-computerised? In other words, how much computerisation the network will be?—by cost-effective-benefits analysis and descriptive analysis, and 3) for a particular programme, the *resources allocations* (mainly budgets) among co-operative activities and the resources allocation within activity, i.e. two-level allocations, which also give out the allocations among the nodes. In such a decision-making process, both non-quantitative and quantitative approaches are needed.

To cope with the above problems, two devices are worked out as useful guidelines, i.e. Top-bottom and two-level planning.

4.2.3 Top-bottom Flow Planning

One important intention of the design is to find out the solutions to the following question: in what *mode*? with which *structure*? by which *policies*, the network will perform most cost-effectively.

Therefore, the overall consideration in the planning and design can follow top-bottom and bottom-top flows of design and planning (Figure 4.2). There are three levels in this flow, i.e. Program, Structure and Function Policy levels.

Upper-level — Program Level:

To fulfil the stated objectives of networking (which will be defined in Chapter Six), there could be several alternative programmes. At the Program Level, a macro-level decision about the number of alternatives has to be made. The alternatives related to whether the network will be run manually or partially computerised or entirely computerised. The alternatives chosen need to be defined. The final decision of choosing one from the several alternatives can be reached by careful cost-effective-benefit analysis, which will be fulfilled at the last stage of this top-bottom and bottom-top flow.

Middle-level — Structure Level:

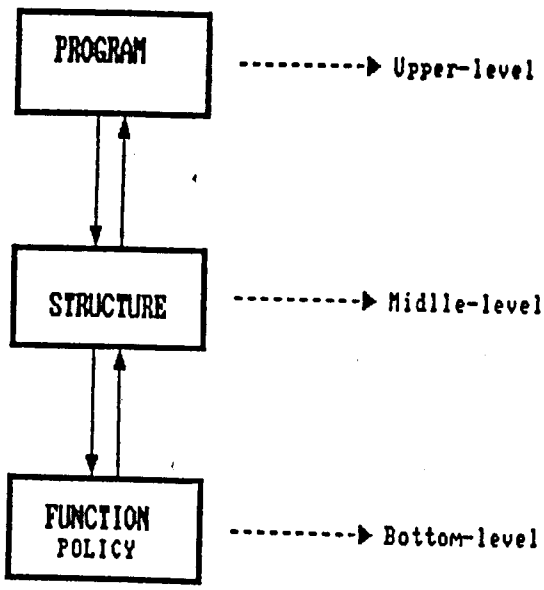
At the Structure Level, the decision about which configuration will be more suitable to particular programme defined at the Program Level (for overall network and particular functions) should be made.

Bottom-level – Function Policy Level:

Under a particular programme, a function with a particular structure, will be characterised by specific policies to adopt.

Following the flow from the top to the bottom, firstly we have to clearly identify and define the alternative programmes. Elaborating the means of processing, resource, equipment

Figure 4.2: Top-bottom & Bottom-Top Planning Flow



and facilities incurred and cost involved for each programme is needed. For example, IR services can be run manually, off-line and online. Different modes have their technological characteristics and facility requirements; Manual IR services require volumes of printed secondary sources or other reference tools while on-line IR services need computer terminals and telecommunication facilities.

Then at the structure level, following the procedures of configuration determination (will be discussed latter), we may be able to decide the suitable configurations to match the different functions in particular programmes since technology employed seems to be related to the structure of the network. For example, off-line (batch) IR services in a network environment, tends to favour centralised configuration.

Different programmes and configurations decide different effectiveness levels and costs of the functions, which needs to be carefully worked out. If we have a look at the function of interlibrary loan, different transmission modes bring out different speed of the services and costs, which also decide the route policies of transactions, and the necessity and forms of union catalogues. Therefore, at policy level, the policies about how to perform ILL function and the policies about trade-off between cost and effectiveness within function of ILL should be worked out. The cost-effectiveness analysis will be carried out under the heading of the design of the individual functions.

Then, conversely taking a view from bottom to top, we can find that in order to perform the function with certain cost-effectiveness, the network needs to be configured in a particular

way and need to take particular programme. The underlying philosophy in the device are embodied in the design of overall network and individual functions.

4.2.4 Two-level Hierarchical Planning

The two-level Hierarchical Planning Device is worked out to help 1) cost determination of individual functions, 2) calculation of benefit/cost ratio and 3) trade-offs between cost and benefit subject to budget limits.

As emphasised earlier, the relationship between functions must be known and utilised in the design of a cost-effective network. In the overall network environment, different functions can play full supporting roles to one another only under the precondition that the budget allocations among the functions are reasonable. The optimum solutions of resource (budget) allocation can be given by the optimisation which includes the maximisation of the effectiveness and minimisation of the cost.

The detailed cost components of each function (activity) will be discussed later (under the design of individual functions).

Resource allocation among the activities and within the activities, can therefore follow two-level hierarchical planning cycles (Figure 4.3). Again, the underlying philosophy is to be embodied in the cost-effective-benefit analysis process.

As discussed earlier, the methods can be grouped into two categories, i.e. non-quantitative and quantitative approaches. In the following sections, the problem areas to which non-quantitative approaches or quantitative approaches are applied, are presented, and particular methods adopted are explained. And finally the indications of chapters devoted to the issues are given.

4.3 Non-Quantitative Approaches–Descriptive Models

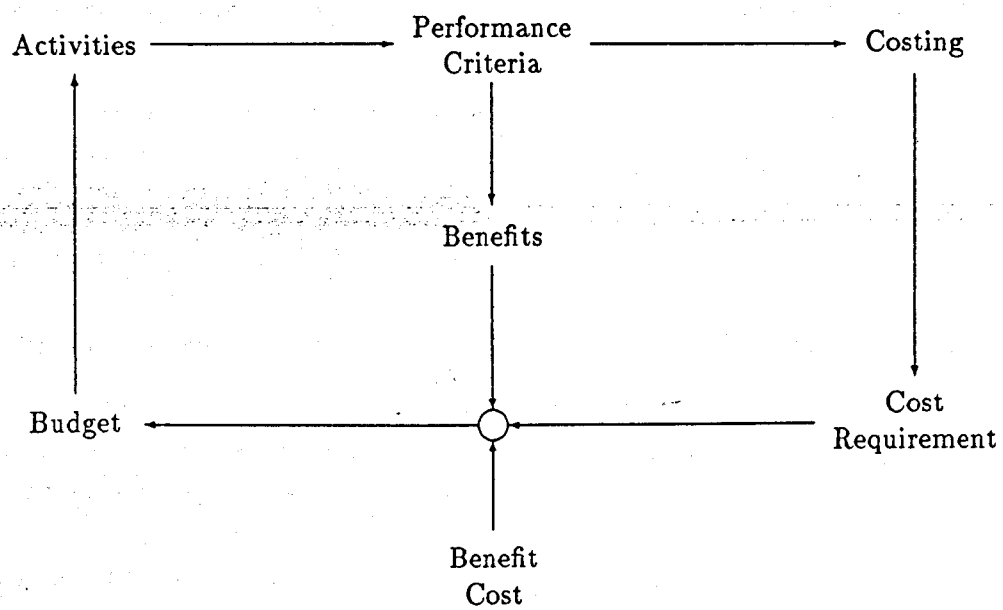
Non-quantitative approaches, referred to as descriptive models, are applied to describing and analysing social, political, psychological problems. The following headings are dedicated to the issues to which non-quantitative approaches are applied.

4.3.1 Description & Evaluation of L&I Systems in China

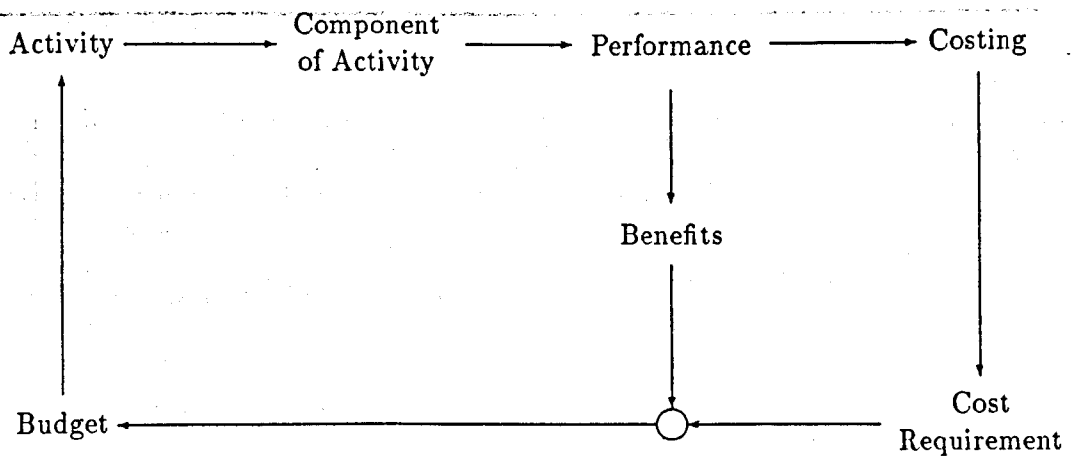
The work is mainly based on the literature review and some interviews. The literature gathered covers a wide range of sources from librarianship to information work to publishing in China. The author did a comprehensive search of literature when she was doing her field work in China. The libraries and information centres visited include the National Library of Beijing, Documentation Centre in ISTIC, STDIC-CAAS, Zhejiang Provincial Library and

Figure 4.3: Two-level Hierarchical Planning

Among Activities,



Within One Activity,



several academic libraries, public libraries at different levels. In the informal interviews, question imposed varied from libraries to libraries since different issues were intended to be explored. Chapter Five is dedicated to describing and evaluating China's Library and Information systems, as a whole, and China's Agricultural library and Information systems in particular. In that chapter, the environmental factor, the present situation of China's (Agricultural) Library and Information systems are identified. The situation of co-operations are assessed and the types of agricultural library and information services and their user groups are identified.

In Chapter Seven, Eight, Nine, the proposals for CA, ILL, UC and IR at national level are based on the literature Review, interviews and the knowledge of the author.

4.3.2 Description of ZALINET

Zhejiang Province is chosen as an example of a regional (provincial) network being designed.

The author conducted a set of detailed surveys in Zhejiang Province. Both questionnaire and interview methods were used to gather resources, activities, operations and background data. The surveys include the following:

1. Zheijing Agricultural Library and information centre Statistics
2. Interlibrary Loan Service
3. Compilation of Union Catalogues
4. Information Retrieval Services
5. User Information Needs and Behaviour
6. Attitudes of Networking from Library Directors

The brief description of ZALINET in Chapter Six, and the descriptions of the alternative programmes for four individual co-operative functions in Chapter Seven, Eight and Nine respectively are based on the survey results, and the knowledge of network theory and the design issues of network.

Chapter Eleven discusses the data collection in details.

4.3.3 Some Design Issues

The design issues to be discussed here are those identified in the design procedures.

Determining the Configuration of the Network

The detailed steps of determination of the configuration is discussed in Chapter Six. It involves the following: 1) the basic knowledge of network configuration, and 2) the survey of practical structure of the system being designed, in terms of management, and existing co-operations, and 3) the characteristics of individual functions and 4) degree of new technologies applied etc.

Bearing in mind, the library and information network tends to have a variety of configuration in one system. They may be centralised in one aspect and decentralised, hierarchical or mixed in other. Attempts are made to determine the configurations for each network function under different alternative programmes in Chapter Seven, Eight and Nine respectively.

Identifying the Objectives of the Network

There are various sources and mechanisms for the definition of objectives that the analyst has at his/her disposal. The analyst's knowledge of the decision problem is an obvious first source. An awareness of the history behind the project can be invaluable. Another possible source of information is the decision makers. Additional origins of information that may be useful for identifying objectives are published material relative to the decision problem.

To obtain those sources, interview and literature review, seem appropriate. Chapter six presents the objective identified based on the types of sources mentioned. And Chapter Eleven discusses the interviews conducted.

Identifying Environmental Factors

Environmental factors of the network being designed are identified by the surveys conducted, literatures reviewed, published statistics and knowledge of the author.

In chapter five, the author discusses and identifies the environmental factors.

Identifying the Resources, Nodes, Link and User Groups

Among the efficient ways are

1. Consulting published statistics, if available; and
2. Surveys etc.

The data related to the identification are widely used throughout the thesis. Chapters Five and Six give a comparatively detailed description.

Defining Performance Measures

To help in studying and selecting the performance criteria, it is advisable to establish some conceptual framework and schema. In Chapter Six, the author presents some framework and schema to indicate a general relationship among cost effectiveness-benefits measures for network and four basic network functions.

The performance measures chosen intend to reflect the objectives to achieve and the problems to be solved. Therefore, the involvement of survey, published data and knowledge of analyst is essential.

Identifying the Constraints

The identification of constraints in literal term will mainly be based on the survey, literature review and knowledge of the author.

As mentioned earlier, the design and planning procedures suit both approaches. In a quantitative sense, the objectives, performance measures and constraints need to be quantified. In any mathematical modelling processes, the objectives are expressed by the performance criteria and measure. From a mathematical point of view, the objectives which are quantifiable, permit the measures, finally the variable to be derived from them. Similarly, constraints, input, output need to be quantified in a mathematical model.

Identification of Alternative Programmes

This is a time of rapid technological changes. The application of computers and other technologies have promoted the effectiveness of libraries and information services. The involvement of those new technologies seem a trend in a modern library and information network. But the degree of the involvement in Chinese circumstances will depend on the analysis of the following:

1. The technological changes in the World;
2. The present situation of China, in terms of economy and technology;
3. The prediction of development in China;
4. The present resource situation in the potenital member libraries; and
5. The future possible resource input etc.

The first three are based on the literature review, while the rest rely on the surveys. After a careful diagnosis, three alternatives can be identified, i.e. manual, semi-computerised and computerised.

Chapter Six discusses the identification and definition of three alternative programmes. And Chapter Seven, Eight, Nine describe the alternative programmes embodied in the individual functions. And Chapter Ten generates the alternatives.

4.4 Quantitative Approaches—Operations Research Models

4.4.1 Introduction

Following the overall design and planning procedures, there are stages of modelling, namely Modelling–One and Modelling–Two. The former refers to the mathematical modelling process while the latter refers to the simulation modelling process. Figure 4.4 and Figure 4.5 show the procedures of the two modelling respectively.

As mentioned above, the identification and determination of objectives usually come first. For the purpose of the mathematical modelling, these objectives need to be quantified. The overall steps can be described as the determinants of what is important (the objective), the controls which decision makers have available to them (the decision variables), and the limits on the range of the controls (the constraints) must be identified first in any planning exercise. If a mathematical model is to be used, then steps (1) and (2) correspond to model formulation.

The determination of quantifiable objectives should be based on the knowledge, the analysis of published source and the situation investigated. That is to say, overall consideration of the standard (if there are some), the common objectives of the library and information systems, and the past and the present situation of the system to be designed should be taken at this stage. While quantification of objectives is the statement of an objective as a mathematical function of decision variables.

After data are collected in step (3), alternatives that are feasible in terms of the constraints are generated and evaluated for their impact on the objectives.

In step (5), a preferred alternative is selected by decision makers through a political selection process. In the final step of the methodological steps, the chosen alternative is implemented.

It is noticeable that the whole processes of both mathematical modelling involve the non-quantitative analysis.

Simulation model was planned at first plan. However, it was affected due to the change of computer system in the university. Thus it has to be left for further research.

4.4.2 Mathematical Modelling in Formulation of Individual Objective Functions

The individual objective functions are formulated to serve two purposes in this project:

Figure 4.4: Procedures of Mathematical Modelling

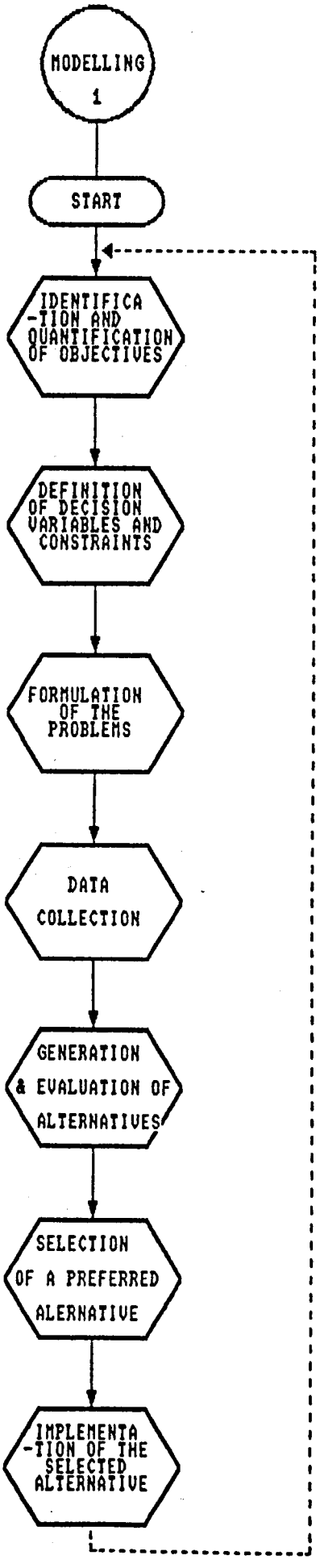
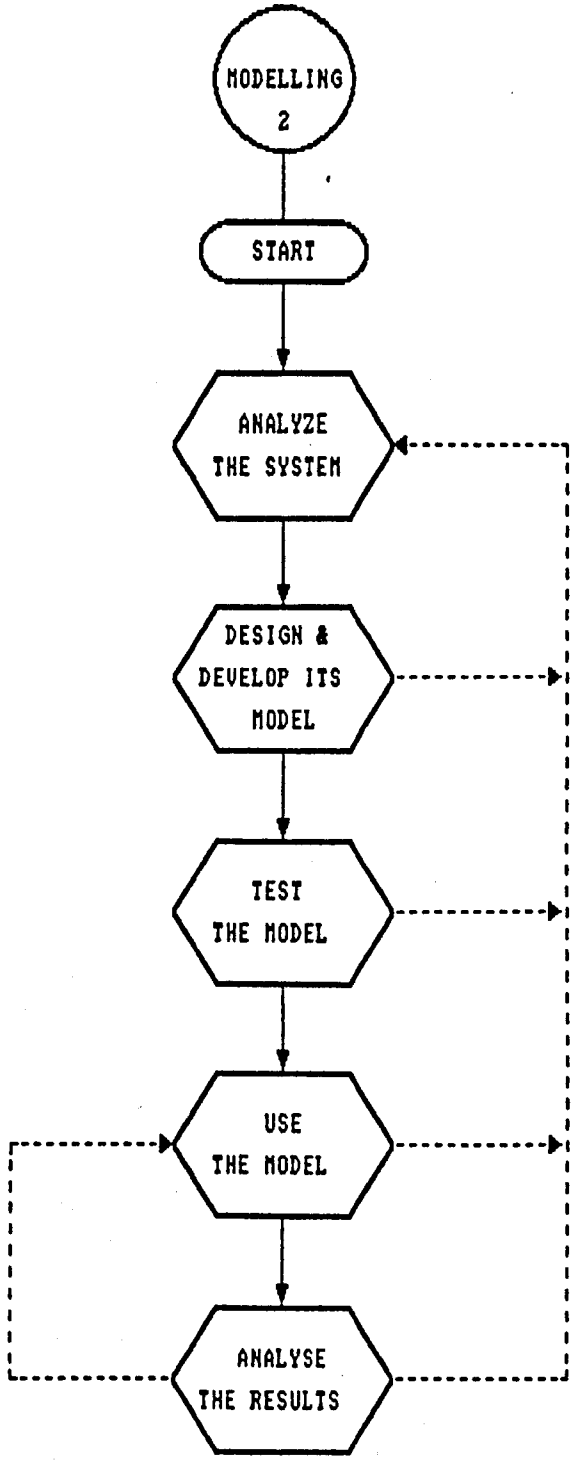


Figure 4.5: Procedures of Simulation Modelling



1. As a device to determine the cost requirements of each objective (activity) by setting desired goals (objective measures)–Analytical Solutions;
2. As an optimisation tool: taking the allocation results (after cost-effective-benefit analysis process and trade-offs between cost requirements and budget levels) to achieve optimum solutions of those effectiveness measures–optimising solutions.

Chapter Ten and Twelve are dedicated to describing the above issues.

Optimal Resource Allocation–CA Programme

Four performance criteria are decided to reflect the objectives of CA Programme in the network. They are:

1. Network Material Accessibility
2. Probability of Satisfaction of ILL (from outside system)
3. Geographical Accessibility, and
4. Local Availability.

The formulations of four objective functions apply linear programming, integer programming and queueing theory. The optimum solutions include the following:

- Optimum total network coverage;
- Optimum overlapping degrees of titles among nodes; and
- Optimum duplicated rates of titles within node and subject.

Chapter seven is dedicated to the formulation of four objective functions. Chapter Ten works out the analytical solutions for the cost requirements for the purchases of stock.

Cost-effectiveness of ILL-UC Services

With three assumptions, i.e. a) UC locally accessible; b) UC centrally available and c) Non-UC available, the nature of interlibrary loan are categorised as three types of transactions: Two, Three and N-body.

The total turn-around time and cost depend very much on the types of transaction while the ultimate satisfaction rate is related to the accessibility and availability of the network stock. A goal programming model is used to solve the decision problems: whether the network will compile UC to help ILL transaction or not? In what forms the UC will be compiled.

Chapter Eight is dedicated to the formulation of the model.

Cost-effectiveness of IR System

A model for cost-effectiveness comparison between three alternatives is formulated by goal programming. The three alternative modes are manual, off-line and on-line. Recall and precision ratio, and response time, etc. are chosen as effective measures. Types of cost are identified as setting-up and staff cost for searching.

Chapter Nine is dedicated to the formulation of the above model.

4.4.3 (Mathematical) Modelling in Overall Network Trade-offs and Generation of Alternatives

The overall trade-offs between activities and levels of effectiveness is necessary because of the resource constraints. The generation of alternatives should be based on cost-effective-benefits. Analytical Hierarchy Process(AHP) is applied to the fulfilment of the trade-off and generation

Claimed as offering a new logic for organising complexity and measure priorities, AHP has been applied to forecasting, decision-making, planning and system analysis (vide Chapter Ten).

To apply this methodology, some hierarchies are needed to establish. In this project, two hierarchies, i.e. benefits of networking, and cost of networking are worked out based on 1) the knowledge of library and information networking; 2) the stated objectives and decision problems of this project etc. Chapter Ten discusses two hierarchies established and the detailed costing of individual functions and network, and identification of benefits from those functions and networking under the three alternative programme.

To avoid the difficulties in some conventional cost-benefit analysis, the results of the costing and benefit identification are not directly used. Instead, they provide both quantitative and qualitative information to assist the AHP process. The matrices for criteria and the priorities are set through a careful diagnosis to reflect the opinions from 1) decision-makers, 2) librarians, 3) users, and 4) the author.

4.5 Data Collection

4.5.1 Data Collection Planning

At data collection planning stage, there are three questions to raise:

1. Why collect data?
2. What data to collect?

3. How to collect data?

Data are important at four stages of this network planning and design project. At the first stage, it describes a situation; in the second it tests theories; when plugged into models, it explains situations; and finally, it predicts.

In this project, two major sources of data are identified:

1. Published Data and Statistics;
2. Survey Data and others

And the usefulness of published data and statistics in this project can be seen through the following aspects:

1. To help determine objective measures;
2. To help set some resource constraints to the fulfilment of the objectives; and
3. To derive average price, unit cost of services, etc.

The usefulness of survey data can also be seen

1. To help set the minimum performance requirements;
2. To assess the existing library holdings, which can help
    - To calculate the total number of the existing collection in the network to be designed;
    - To categorise the library stock levels;
    - To assess the collection strength and bias (in terms of speciality and form); and
    - To derive average stock level.
3. To assess the resources (apart from stocks);
    - To estimate the resource available in the network;
    - To categorise library resource levels;
    - To help set resource constraints;
    - To derive average resource level.

Therefore, the reasons why we need to collect data are obvious in the design and planning of a network model.

During the planning stage, data to be collected was worked out under the four headings: resource, activities, operations and background for four functions. Then questionnaire and interview questions were prepared to meet the ends. (see Chapter Eleven)

Apart from the above two methods, direct counting was also applied to gathering request data and some published sources were also used for data collection purpose.

4.5.2 Statistical Analysis

Both descriptive and inferential statistics are applied. In particular, Chi-Square and Kolmogorov-Smirnov goodness of fit test are used to test the conformity of the request data with the empirical distribution—Poisson Distribution. And Analysis of Variance is applied to test the difference of request rate among libraries and subjects etc. The tests were carried out by a computer program (package) called Microstat.

Chapter Eleven is dedicated to discuss the data collection and statistical analysis.

4.6 Conclusion

As mentioned in Chapter Three, the "systems approach" is both a philosophy and a body of analytical techniques. Methodology is a set of principles of methods. The analysis and design of such a complex system as a network requires the construction of descriptive, mathematical and hybrid models. Therefore, a conclusion can be drawn that the methodology applied in the project is a combination of non-quantitative and quantitative approaches and the methods adopted cover a wide range. This aims at making use of the advantages of these different approaches but avoiding their disadvantages. The specific methods applied include the following:

1. Descriptive Analysis;
2. Survey Methods;
3. Mathematical Programming: linear programming, integer programming and goal programming;
4. Cost-effective-benefit Analysis–AHP;
5. Cost Analysis; and
6. Statistical Analysis etc.

Chapter 5

General Overview of Library and Information System in China

5.1 General Description of China

5.1.1 Geographical Scale and Population

China has a total land area of 9.6 million square kilometres, accounting for 6.5 per cent of the total land area of the world. The population of the country, according to the census figure, 1982 was 1,031,882,511. And the recent census (1989) discloses the figure has risen to over 1.1 billion.

Because of complex natural conditions, the population distribution in China is quite uneven.

5.1.2 Administrative Division

The country is divided into 22 provinces, 5 autonomous regions, and 3 municipalities directly under the Central Government; provinces and autonomous regions are divided into autonomous prefectures, counties, autonomous counties, and cities; counties and autonomous counties are divided into villages, national villages, and towns. (Figure 5.1)

By the end of 1985, China had 30 provincial units and 165 prefectural units, 311 cities, 2046 counties and 620 municipal districts. Conventionally, China is divided into six administrative regions: North China, North-East China, East China, Central-South China, South-West China and North-West China(CASS, 1989). (Figure 5.2)

Figure 5.1: Administrative Division of China

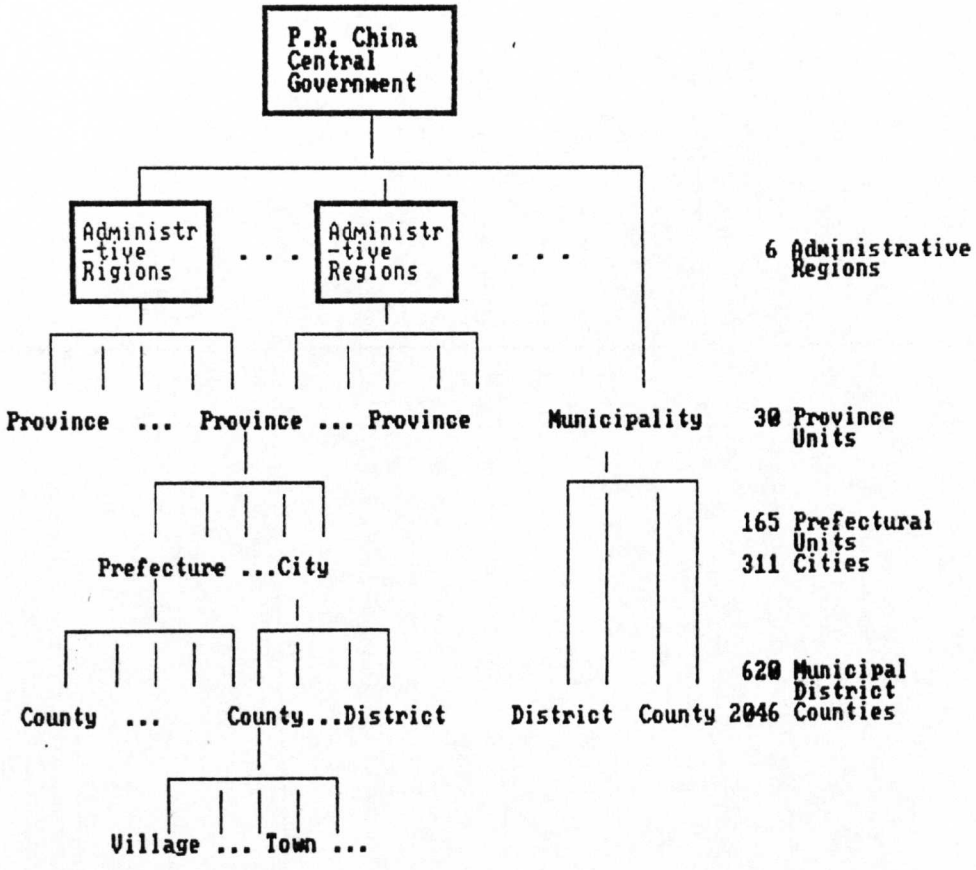


Figure 5.2: Map of China

Table 5.1: Statistics of Agricultural Research, Education and Information Services

Category	Number
Agri. Universities & Colleges	70
Agri. Schools	359
Agri. Research Institutes & Divisions (Over County Level)	2,145
Agri. Librarians Documentalists & Information Officers	20,000
Agri. Sci-tech Personnel	328,000
Agri. Books Published since 1949	2,000
Agri. Periodicals	2,291

5.1.3 Transportation

Transportation has been steadily developing in the new China. Railways are the mainstay of China's transport network. China's aviation has developed rapidly in recent years. Over 100 domestic air routes fan outwards from Beijing to over 80 large and medium-sized cities as well as remote regions and border areas. There are direct air routes between Beijing and each province, municipality and autonomous region.

5.1.4 Agriculture

China is an agricultural country, for which agriculture is an economic resource. The importance of agriculture to the development of economy can be seen in China's agricultural research, its education, and the expansion of its library and information services during the last few decades, which have laid a solid foundation for the modernisation of agriculture. Table 5.1 gives a general picture of China's agricultural education, research and information services and the major group of users, i.e. sci-tech personnels (Zhang, 1990).

There are 1377 agricultural research related organisations at provincial and higher levels, accounting for 29% of totality (i.e. including industrial, business and medical research organisations etc. at corresponding levels). And agricultural sci-tech personnel at those organisations are around 115,430, which occupies 20.0% of total number of sci-tech personnel at corresponding levels. Total number of employees at those organisations is 182,364, accounting for 23.4% of totality.

At county level, there are 2,524 agricultural research related organisations, which occupies 77.3.% of totality; while agricultural sci-tech personnel amount to 67,782, occupying 87.5% of total number of sci-tech personnel at corresponding levels. It can be seen clearly that at county level the emphasis of research has been put on agriculture.

As for the resource input to the research projects, it has been estimated that 25% of total manpower and 17% of total budgets have been allocated to agriculture.

However, since China is one of the developing countries; certain unfavourable conditions, such as a big population (over 1.1 billion, of which agricultural population occupies 80%), low rate of planted land per head, together with some historical and political reasons have led to the following consequences:

1. The rural economy is still underdeveloped;
2. There exists a shortage of qualified personnel in agricultural science and technology;
3. Agricultural education is far from being adequate;
4. A large proportion of the total population in rural areas is semi-literate and illiterate.
5. Traditional means of production still dominate so that the productivity in agriculture is rather low; and
6. There is little change of the situation for which hundreds of millions of Chinese farmers are engaged in producing food, etc.

Faced with the above situations, the government has devised a number of new polices, which benefit the development of rural economy. Among them are:

1. Lessening taxation in the countryside;
2. Raising purchasing prices for farm and sideline produce;
3. Allowing some peasants to become rich sooner and help the poor;
4. Readjusting the rural economic structure;
5. Developing township enterprise and supporting agriculture with industry; and
6. Developing rural credit, etc.

The reform of the rural system, regarded as one of most important impacts, consist of the following:

1. The adoption of an output-related system of contractual responsibility;
2. The increase in specialised households and the development of economic co-ordination and co- operation;
3. The relaxation of control and the invigoration of circulation;
4. The separation of commune management from government administration;
5. The reform of state-run farms; and
6. The application of technology in agriculture etc.

A long-term aim is to modernise China's agriculture and then its economy as a whole, so that China will have an agricultural base with brilliant prospects:

—China will rank as an advanced agricultural nation;

—China will apply the latest technology to agriculture and integrate technology with traditional practices to form a technological structure with Chinese characteristics;

—China will have diversified rural economic system;

—China's rural economy will vigorously and effectively unify economic, social and ecological results; —China will have new generation of farmers with a better knowledge of science and management. (CASS, 1989)

...

This is the profile for a contemporary rural economy with Chinese characteristics. The realisation of these objectives will be a process taking 70 to 100 years.

5.2 Structures of China's Library and Information system

Before the author examines China's agricultural library and information system in particular, it is important to have an overall view of the overall totality.

The overall Library and Information System of China can be described and discussed in terms of Organisations, Information Resources, Dissemination, Personnel, Services, Utilisation and Co-operation.

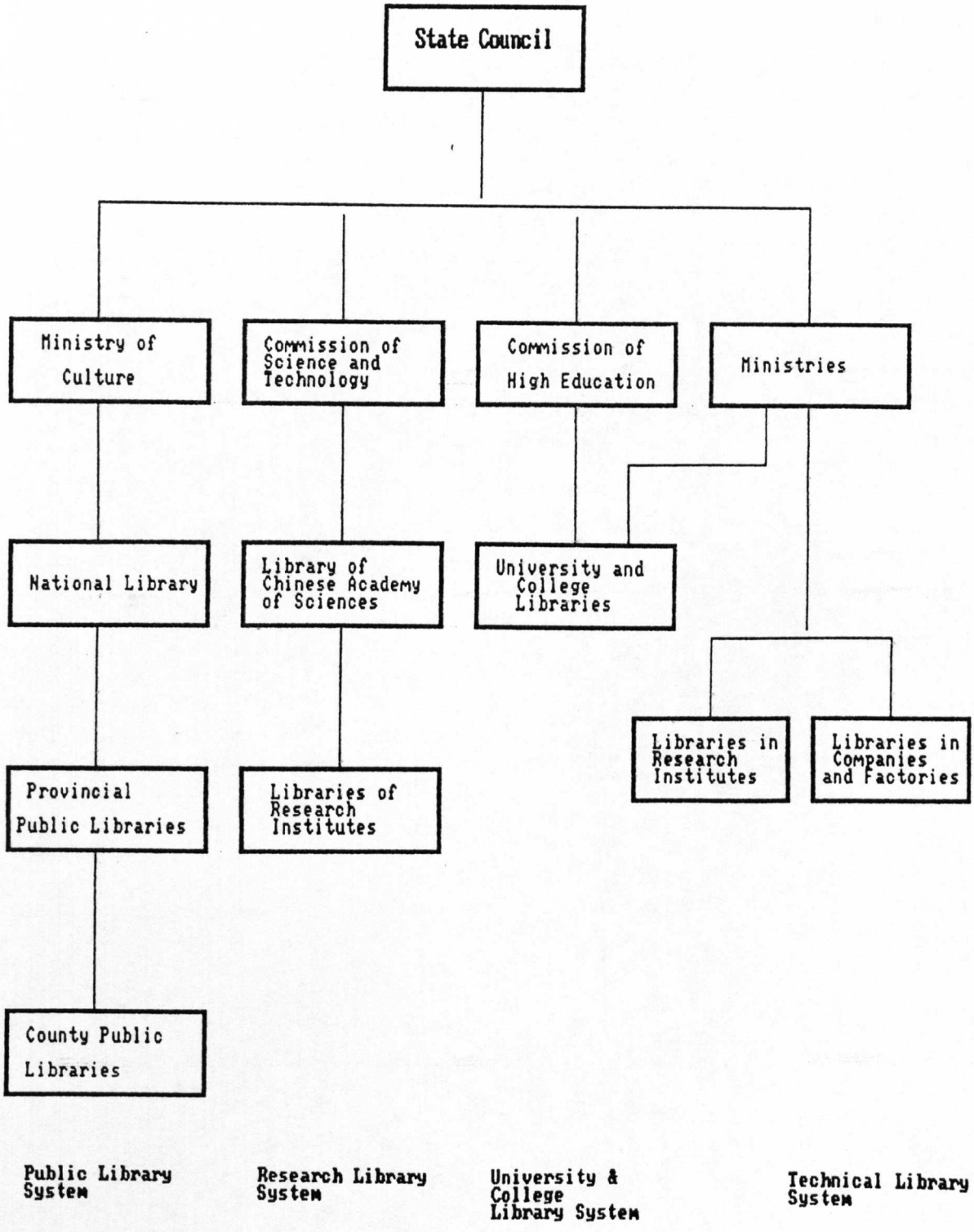
5.2.1 Organisational Structure

The Library and Information System in China consists of the following subsystems: 1) Public Libraries, 2) College and University Libraries, 3) Research Libraries, 4) Sci-tech Information Institutes, 5) Patent Information Agencies, 6) Standard Information Agencies, 7) Ministry Libraries, 8) Trade Union Libraries, and 9) School Libraries, of which the first four subsystems are of major concern in this thesis. The overall structure can be seen in Figure 5.3. Those subsystems have some characteristics in common, but each also has its own distinguishing characteristics. For instance, the Public Library System has been established in correspondence with the administrative areas while some other systems have been set up along with administrative organisation.

The characteristics of different library and information systems can be summarised as follows:

1. **Public Library system**

Figure 5.3: Overall Structure of China's Library & Information Systems



a) Erected on a series of administrative levels;
b) With a national centre and several regional centres;
c) A composite star configuration.

2. **Academic(Research) Library system**

a) Erected on administrative organisations;
b) With multiple national centres;
c) A ring mixed with star configuration.

3. **University Library System**

a) Erected on administrative organisations;
b) Without national centres or other centres;
c) A ring configuration.

4. **Sci-tech Information Institute**

a) Erected on a series of administrative levels;
b) With a national centre and several regional centres;
c) A hierarchical mixed with star configuration.

The different types of libraries and information centres are administered by different sectors of organisations, e.g. the Public Library System is under the direction of the Ministry of Culture; the University and College Library System is under the direction of the Commission of Higher Education; the Academic (Research) Library System is under the direction of the Commission of Sci-tech; and the Technical Library System is directed by different ministries. The libraries are also administered by local governments. Therefore, the libraries usually get the technical supervision and administration supervision from different bodies. One disadvantage appeared in the over-all system can be seen that the libraries are treated as an administrative unit, which prevents the libraries from exerting multi-functional and service oriented effects. Furthermore, because the strict division of libraries have resulted in barriers in connections among libraries of various systems.

As for the structure of sci-tech information institutes, the fundamental organisation structure for information institutes is erected on a series of administrative levels, as with Public Libraries. This means that there are major information institutes at the provincial and municipal level. Large cities have also established an corresponding information institute under the direct control of the local governmental agency for science and technology. Prefecture and districts represent the lowest level of official administration, which have corresponding information services. However, the information institutes under ministries and academies have some differences. Most of them are affiliated to their parent organisations. In most cases, the libraries are part of the information institutes. Therefore, the structure of information institutes of government administrative levels is supplemented with systems of enterprise and subject information departments — a fairly widespread pattern. Those information departments are naturally organised to meet the information needs of their units' employees and

therefore do not compare with public information services but with company libraries elsewhere. But at the same time they constitute the most immediate points of linkage for many potential users.

The above varied structural characteristics complicate the infrastructure of Chinese Library and Information system. It mixes all the standard configurations.

Generally speaking, libraries in China are weak in many respects, and with the exception of a few very large public libraries(e,g, the National Library of Beijing and the Shanghai Municipal Library), they do not contribute significantly to the dissemination process of sci-tech information. In contrast, information institute in China are major supplier of information both to research institutes and to industrial enterprises. In addition, they occupy a role namely as suppliers of reports on technological tends for the use of decision makers. This phenomenon was caused partly by the fact that China has over emphasised the distinction between library and information institute in term of function orientations and intellectual levels etc.. Much more attentions have been paid to develop the information institutes in China.

One way in which the Chinese Government promote information exchange between public services, local information units and users in various organisations is through the informal information networks. The information networks are frequently mentioned as primary media for information exchange on both informal(e.g. meeting, and seminars) and formal (e.g. distribution of literature) basis. Some more formal co-operation activities (e.g. ILL, UC, and CA) have been carried out in some scales.

To summarise, China has, on the basis of a socialist system, developed a structure of library and information system basically at the central and local levels which are geared to serve the planning administration and the researchers in state-operated research institutes and enterprises; they emphasise on supplying information on scientific research but do not appear to be focussed on information regarding laws and regulations, market potential etc, which in some capitalist economy is of primary importance. Contradictionally, with such centralised social system, only a week guiding control is exercised by the government over the information system. That is due to the fact that China had not created a special organisation for co-ordination and promotion of library and information services until 1987. And even though the co-ordination can only be executed at higher level after the establishment of inter-ministry co-ordinating organisation. As indicated in the structure of the system of information institutes, the State Science and Technology Commission is principally responsible for this work. In reality, however the Institute of Scientific and Technical Information of China(ISTIC) carried the main responsibility for the promotion of information dissemination, partly since it is constituted as a separate unit under Policy Research Bureau at State Science and Technology Commission. It should be noted that the institutes which are placed under other government organisations and even local authorities, do not formally recognise ISTIC as a co-ordinating body. So the existing complicated administrative system have made the co- ordination rather difficult to carry out. However, in 1987, there established an inter-ministry co-ordinating organisation in ISTIC. It is hoped that more communications and co-operations will be carried out across different ministries, different systems and different areas.

Table 5.2: The Publication and Collection Growth during last Thirty Years

quanti-ty / time	No. of Publications			Collection (Resources)					
				Public		College		CAS*	Total
	Books (10^8)	Journals (10^8)	Newspaper (10^8)	No. of library	stock (10^4)	No. of library	stock (10^4)	stock (10^4)	Stock (10^4)
1950	2.7	0.4	8.0	68	2,600	132	794	63	3,457
1956	17.8	3.5	26.1	375		229			
1966	35.0	2.3	36.7	477		435			
1978	37.7	7.6	127.8	1256		598			
1983	58.0	17.7	155.1	2038	20,000	753	24,862.6		
1985					24,263		31,525	1,800	57,588
Growth Rate	21.5%	44.3%	19.4%	30.0%	9.3%	5.7%	39.7%	28.5%	

5.2.2 Information Resource Distribution

Information resources in the different types of library systems have been developed greatly since the establishment of the People's Republic of China. Table 5.2 shows the publication and the collection growth during thirty years.

But because of the low starting stage and poor foundation of collection development, together with the historical and political influences, the economic difficulties and some mistakes in the management, there exists two conflict crisis in the collection development and resource distribution. (Yang, 1986)

Crisis One — lack of information resources, which can be summarised in the following five aspects:

1. The total library collections are rather insufficient and the collection per head surprisingly low. It has been estimated that the total collections nation-wide is 6×10^9 and 0.5-0.6 book per head, which is lower than the international average level. (Annexe 5.1)
2. Annual acquisitions and subscriptions lack comprehensiveness and completeness. For instance, the annual acquisitionsat most key universities in China are only as much as one-fourth of that at some universities in the United States.
3. The import rate of foreign publications is rather low. It is estimated that the import

rate of foreign book, foreign periodical and other foreign publications at national level are 13%, 16.6% and 14.3% of the total output respectively.

4. The slight increase of budget can not keep up with the inflation so that the purchasing power has been impaired.

5. The publishing business has a depression period so that the the amount of publication, especially scientific publications have been cut down in China.

The above factors have resulted in the low coverage of information resource in China.

Crisis Two—Low Utilisation of Information Resources: contradictorily, the existing insufficient information resources in China have not been fully utilised. Some estimates show that the utilisation of information resources are 35 percent in public library sector, 45 percent in university and college library sector. Actually the estimates were quite optimistic. The causes of low utilisation of information resources are various. The following could be accounted for the major causes: 1) unconsciousness of the (potential) users about information; 2) lack of the effectiveness of the information services; 3) lack of co-operation and resource-sharing between information services; and 4) imbalance of the development in information resource among areas. The second crisis is more alarming than the first one. It needs more attention and action.

5.2.3 Structure of Dissemination

A typical indicator of information dissemination can be found in the publication of periodicals. With an overall view at the process of information dissemination, we can find the following characteristics:

1. Among sectors, the research institutes play an overwhelming role in the processing of sci-tech periodicals (around 50%); (Baark, E., 1984)

2. Information institutes contribute more roles to the process of information dissemination than libraries;

3. In terms of subject-wise distribution, the Soviet heritage in China has provided a relative bias towards applied science and engineering (around 66.0%); (Baark, E., 1985)

4. Within a subject, a bias has been placed in the processing of sci-tech information suited to the research level at the cost of practical, marketing and legal information; and

5. There is a large proportion of "internal publications" accounted for the total output of periodicals, which is rare in the other countries.

The bias of dissemination towards scientific research, applied science and engineering can be accounted for the influence of the Soviet model which evidently stressed scientific communication and scientific information, especially in the areas of applied science and engineering.

Table 5.3: No. of Staff in three Types of Library

Category	Public Library	Chinese Academy of Science	University Library
Total No. of of Staff (person)	8,856	2,538	30,483
No. of Libraries	284	136	950
Staff/Library (person)	31.2	18.6	32.0
Book/staff (item)	1.3×10^4	0.8×10^4	1×10^4
User/Staff	25.3	83.3	

The bias of the dissemination role towards information institutes can be accounted for by the over emphasis on the distinctions between libraries and information institutes, in terms of functions and intellectual levels.

An overwhelming proportion of "internal publications" in the dissemination can be regarded as an almost unique phenomenon in the world. The "internal publications" are those not open to public subscription and are mailed directly from the publishing unit to an selected number of other units considered relevant. It is claimed that the distribution between public and "internal" distribution is based on criteria of quality level, but a much more likely explanation can be found in traditions of secrecy and restricted information flow. The phenomenon of "internal" distribution seems to affect the structure of information dissemination less in quantitative than in qualitative terms, i.e. a more centralised and probably less flexible mode of distribution. The "internal" mode of circulation also appears to be directed towards institutions rather than to individual researchers (Baark, 1984).

Apart from periodicals, China is issuing a rather large number of abstracting, reporting, and indexing periodicals since early 1980s, of which quite a large proportion is translation oriented. It is clear that the language barrier has been an important impetus for the establishment of such large and widespread indexing and abstracting activities. This kind of processing of foreign and domestic information simultaneously functions as a "current awareness" service, providing additional assistance to the lower echelons of scientists. But a serious problem is that many researchers in China seem still unaccustomed to making use of such secondary service. It should be noted that these activities are continued and are even growing in spite of an apparently growing foreign language capacity in China.

5.2.4 Personnel Structure

Generally speaking, in China, with the development of library and information systems, both the quality and quantity of the personnel in the systems have been improved. Table 5.3 shows the quantity of the personnel in different types of library.

Table 5.4: No. of University Graduates

category	Public Library	Chinese Academy of Sci.	Univ. Library
Total	8,856	2,538	30,483
Univ. Graduates	1,632	1,720	16.338
Proportion	18.4%	67.8%	53.6%

It is noteworthy that the libraries in China have followed such a role to recruit their staff, i.e. per staff in correspondence with 1×10^4 books. However, whether it is an optimal allocation needs further studies. Similarly, what is a reasonable ratio between staff and user remains to be answered. The reasonable consideration depends much on what modern technology, overall personnel quality, collection structure and service types the library has. To have a picture of the situation in the world, we can compare China's university libraries with the equivalence in the other countries. Investigation has shown that in China, every staff member usually serves 45 students, while 211 in Britain, 388 in France and 211 in West German respectively. The big gap has proved the fact that effectiveness of a library largely depends on the quality and efficiency of staff, modern technology, development level of libraries and level of users. Therefore, it is more important to analyse the quality than the quantity of the staff when evaluating the structure of the personnel.

The measures of the quality of the personnel structure usually consist of qualification, speciality, experience and some personality factors.

In China, qualification structure is usually used as one of the most important measures to assess the quality of the personnel structure. Table 5.4 has shown the qualification structure in three types of library.

The above statistics has disclosed that in both Chinese Academy of Sciences and university library system, the university graduates occupy more than half of the staff. The proportions are 67.8% and 53.6% respectively. In comparison, the proportion of university graduates in public library system is much lower than the former two.

The speciality structure of the staff is also regarded as an important measure of the quality of personnel structure. For instance, in a research library, the best speciality structure would be the combination of relevant specialities to the parent bodies, librarianship or information science, computer science, linguist and social science etc. Due to historical reasons, there has been a shortage of qualified librarianship and information science personnels. Table 5.5 has shown the proportion of the staff who have had the education of librarianship and information science.

It can be seen from the table that the staff who are qualified in librarianship and information science occupy rather a small proportion of the totality. It implies that the training programme of librarianship and information science for non-qualified staff are necessary to improve the quality of personnel structure and finally the effectiveness of library and infor-

Table 5.5: Proportion of the staff qualified in librarianship and information science

Category[a]	Public Library	Chinese Academy of Sci.	Univ. Library (Shanghai) [b]
Total	8,856	2,538	2,399
Librarianship & Info. Sci.	946	174	299
Proportion	10.7%	6.8%	12.5%

[a]Adapted from Huang, C-Y (1987) On the basic structure of China's library systems *Newsletter of Librarianship* 3(4): 39-54

[b]including 58 university in Shanghai only.

mation services. As important as that, librarianship and information science qualified staffs need some training in other specialities of science and technology.

An ideal library staff or information worker should possess the knowledge of librarianship and information science, natural and applied science and foreign languages. And a reasonable personnel structure, therefore, will not be just a simple composition but a comprehensive, interchanging and infiltrating knowledge in combination.

5.2.5 Service Structures

Viewing the development of library user services in China since over thirty years ago, we can notice two changing trends. Firstly, the services have changed from single function, i.e. lending only, to multi-functions. Secondly, the services have expanded from document services to information services.

The present structure of user services is composed of the following:

1. *Circulation of the Documents (lending and reading)*, which is the basis of the traditional services. As far as the forms of the lending is concerned, there appears interlibrary loan, reservation, mailing lending and mobile libraries etc. As regards to the reading services, open-access has become the direction of the development. According to the investigation in 93 university libraries, there are 86.7 per cent of those libraries which have adopted the open-shelf policies. This phenomenon has broken the traditional and stubborn philosophy of "Book-keeping".

2. *Photocopying Services*, which are rapidly developing services in the library services since libraries have been equipped with reprographical and micrographical facilities. It has become a major and imperative service. It has been estimated that there are 95 per cent of university libraries which have been equipped with photocopying machines, and that each library in the system of the Chinese Academy of Sciences has at least one machine.

3. *Reference and Enquiry service*, which has become a quite popular service in China recently. The statistics collected from 38 major public libraries in China has shown that, the libraries with this type of services occupy 81.6 per cent.

4. *Bibliographical Services*: In recent years, there have started some subject bibliographical services to satisfy users' needs. In 1985, university libraries printed 172 types of indexes and bibliographies altogether.

5. *IR and SDI Services*, which have been developed greatly with the establishment of some computerised IR system. Since 1980, around sixty International on-line IR terminals have been installed in some big cities. The number of topic searched annually has reached 2,000. Besides, various kind of bibliographical databases have been purchased and tapped. These have laid a foundation for the national or regional computerised IR systems.

6. *Information Services*, which are referred to as the Information and Investigation Services for research projects. This type of service has played a very important role in supplying relevant information directly to researchers and decision-makers, and has functioned quite effectively. And there have emerged some other services like

7. *Current Awareness Services*;

8. *Translation Services*; and

9. *Training Services etc.*

5.3 History and Present Status of Co-operations among Libraries and Information Centres in China

In China, the establishment of a library network is presently under way, and there exists various kind of co-operations and resource-sharing among libraries and information centres. Actually, in China the history of networking can be traced back to the late 1950s. There appeared regional or professional library networks on different scales at that time. According to the "National Book Co-ordination Program" in 1957, a "Book Group" was set up to assume the role of co-ordinating and projects-making. Late on, two national Central Libraries Committees were established. Then there established nine Central Libraries Committees at regional levels. Each of these committee is composed of those local libraries having the most substantial collections and well-founded vocational services. The task of the Central Libraries Committee is four-fold:

1. To assist the organising and managerial set-up as well as leading departments of scientific research in their overall planning of library services;

2. To study and solve problems regarding the division of labour and co-operation among Central Libraries in the realm of acquisition, co-ordination, exchange and interlibrary loans, etc.;

3. To study and solve problems of centralised cataloguing, the compiling of union catalogues, the reporting on newly published books, and also to make plan and devise for their realisation;

4. To study the problem of raising the vocational level of library staff and also the problem of initiating and promoting spare-time education (Lee, 1982).

Right after these Central Libraries Committees were formed, they started to work on the following items: 1) co-ordinated book and periodicals acquisition at a regional or national level, 2) the centralised cataloguing, 3) the allocation and exchange of duplicates, 4) the compiling and publishing of union catalogues, and 5) reporting on new publications through bulletin, and 6) the training of staff by groups at set period of time etc.. These items showed already the characteristics of library networks, and laid foundation either vocationally or organisationally for national networks. And it could be regarded as library networking of an early stage.

During the eight years after the establishment of Central Libraries Committees, or during 1958-1965, library services in China had undergone a marked development. According to the statistics taken in 1964, the aforementioned 11 Central Libraries Committees embodied 105 libraries of various departments and lines of profession, with a collection total of over 70,000,000 volumes. These Committees had undertaken the following work: 1) issuing interlibrary reader cards; 2) holding exhibitions of new books or of publications and documentation on specialised topic; and 3) founding of centres of catalogue cards, whereby the Central Libraries Committee No. 1 had accumulated over 950,000 catalogue cards in various language. Besides, as a result of co- ordinated acquisition, the number of duplicated copies fell steadily, whilst, the variety of book titles increased. Thus full use was made of the country's limited foreign currency. During this period, over 300 union catalogues at regional or national level, had been published. Nevertheless, due to the "Cultural Revolution", the whole field of library service in China had suffered serious damage. The library networking in its early stage had unavoidably been paralysed.

As from 1976, library services in China entered a period of recovery and progress. The central Libraries Committees have revived one by one. Some regional committees, being not yet re-established, resumed work under the temporary form of co-operative committees or co-operative groups. The following examples can give us some pictures of co- operation, resource-sharing and networking in the present days of China. For instance, the Library Co-ordination Group in the locality of Beijing was founded in September 1977, having its member 18 libraries belonging to the three lines: public libraries, university or college libraries, and research libraries. The major task of this group is to study and dissolve the problems of co- ordination among libraries in Beijing through consultation. In 1980, the Academia Sinica established a "Publishing, Library, and Information Committee" to enhance the function of leadership in these areas. In 1981, the Commission of Higher Education founded its "University and College Library Service Committee". Comprised of representatives from 50 institutions of higher education, this committee functions as a leading organisation guiding the work of university and college libraries all over the country. One of its responsibilities is the co-ordination among its member libraries. An Administrative Bureau of Library Affair was set up under the Ministry of Cultural, which is a necessary organisational preparation for the

establishment of national networks of libraries. With the setting up of this Bureau, all public libraries now subject to a central leadership and find it also quite a facility in negotiation for co-ordination with libraries along other lines.

Through years of combined efforts by staff members of libraries as well as sci-tech information institutes, both Classification—"A System in Use in Chinese Libraries" and "Chinese Thesaurus" have been compiled to promoted the standardisation of documentation. The former, together with another tool book "Chinese Cataloguing Rules for Books and Documentations", form a set of China's own comprehensive classification rules. They are presently being adopted by 90% of the libraries and information institutes in China. It is hoped that these two tool books, as a foundation, by revising from time to time and stressing its common points with other classification rules, might finally be received as national standards. And they also might facilitate their cross reference with other classification rules, home and abroad. As a component part of information processing of Chinese Characters, "Chinese Thesaurus" was published in 1981, which has created the prerequisite for initiating automatic retrieval of information and documentations, and for the building of a nation-wide network for on-line retrieval as well. (Xu, 1882)

It has been recognised that the organising and building of a nation-wide network is a matter of common concern to users as well as the staff of libraries and information institutes. The four modernisation of China needs a multi- functioned library and information network, which should be flexible in adaptability and good in co-ordination.

Nevertheless, comparing with the advanced countries, the development of co-operation, resource-sharing and networking in China is admittedly left behind. It is still at the early stage of development. It has been faced with the following unfavourable constrains:

1. *Technical*: e.g. lack of modern technology, incompatibility of technology, and imbalance of technology development among areas and subject fields etc.;
2. *Administrative*: e.g. double leadership resulting in the lack of independence of libraries and information centres, and corresponding bodies resulting in low efficiency, unitary functions, and unnecessary duplications etc.;
3. *Financial*: e.g. tightened budgets in almost every libraries and restriction of foreign currencies; and
4. *Motivation*: e.g. the idea of self-sufficiency in the library management, the fear of losing autonomy and the fear of being added more work load etc..

The above review has given a critical overview of the overall totality. There exists many common characteristics in China's Agricultural Library and Information System. Nevertheless, due to its subject nature, organisational structure and users groups, China's Agricultural Library and Information System has its own distinct characteristics. The following section is aimed at exploring those characteristics.

5.4 Overview of China's Agricultural Library and Information Systems

5.4.1 Background

The aforementioned unfavourable situations in agriculture have hindered the further development of agriculture and the advancement of agricultural modernisation. This further impedes the development of agricultural library and information services. In their turn, the undeveloped and inefficient library and information services cannot perform their roles well of enhancing agricultural production, and promoting education, research and marketing. This creates a vicious circle.

Since the reforms were carried out in rural economy in 1983, great changes have taken place in rural areas. The emergence of "specialised household" and "household responsibility" production pattern, of demonstration technological villages and "Star-plan" items have shown the increased demand and changed orientation on agricultural information by both sci-tech personnel and farmers. Their information needs now include not only scientific and technological information but also practical and marketing information. This phenomenon has challenged some existing incompatible performances of agricultural library and information systems, where 1) the libraries and information services in research institutions and universities close their doors to the outside; 2) the libraries and reading rooms at county and village levels are stocked with small amounts of agricultural books with no chance of satisfying the increased needs of farmers, and 3) there appears ignorance of technical and practical information.

Therefore, it is of vital importance to set up a system with sufficient information resources accessible to all types of users; this calls for scientific allocation of information resources, and effective dissemination and services. The aim is a long-term and stable development of agricultural economy guaranteed by the aid of science and technology. One of the most effective ways of realising such an objective is to establish co-ordinated networks with unified goals, and resource-sharing.

The characteristics of Chinese Agricultural Library and Information Systems can be described and discussed in terms of their organisational structures, the availability and distribution of agricultural information resources, dissemination and services of agricultural information etc. The author intends to give a critical overview of the present situation and to emphasise the necessity and impetus, favourable conditions and constraints of co- operation, resource-sharing and networking in China.

Before going into the details, the author tries to give a brief description of some of the characteristics of Chinese agricultural library and information systems, which may distinguish them from those in other countries:

1. Mixed nature of the system structure, caused by the multidisciplinarity of agriculture, the two levels of agricultural operation and the multiple administration of agriculture related organisations.

2. Bias in the distribution of agricultural information resource as regards geographical areas, different sectors and organisations.
3. Bias towards the dissemination of high-level sci-tech information;
4. Predomination of "internal" mode of distributing agricultural information; and
5. Ironically, the failure to exercise adequate control in co-ordination, co-operation and networking in such a centralised social system, etc.

5.4.2 Organisational Structure

The structure of the Agricultural Library and Information System in China is complicated. Figure 5.4 intends to illustrate the mixed nature of the system, which includes the major sectors (three out of five). It can be seen clearly that in the field of Agriculture, the structure of the Library and Information System is not rigidly hierarchical. In a broad sense, agriculture includes the following sub-fields — Agricultural plantation, Forestry, Animal Husbandry and Fishery etc. Therefore, in China, there correspondingly, exist three main administrative systems under direction of the Ministry of Agriculture, Animal Husbandry and Fishery, the Ministry of Forestry and the Committee of Township Enterprise respectively. With four horizontal levels i.e. national, provincial, prefectural and county levels and five (three illustrated in the diagram) vertical sectors, i.e. research, administration and education sectors, the links between these various libraries and information centres are loosened and communications are difficult; the governments at each level have direct responsibility for administering the organisations of the three sectors within the levels. But the three types of organisations—at each level—have no direct link between them, not to mention their libraries and information services. Within the sectors, the upper level organisations indirectly administer the lower level organisations since they have to share the administration with the lower-level local governments, that is, there is a so-called double-leadership system.

The orientation of agricultural libraries and information centres in China are characterised by their patrons or parent organisations. They can mainly be classified into the following five sectors:

1. **Research**: the libraries or information divisions in the academy of agricultural science, or agricultural research institutes;
2. **Education**: the libraries and information divisions at agricultural university and agricultural schools;
3. **Administrative**: the libraries and archive centres in Governmental Agricultural Departments;
4. **Production**: the libraries or reading rooms in farms and villages;
5. **Others**: agriculturally relevant organisations.

Figure 5.4: The Agricultural Library & Information System in China

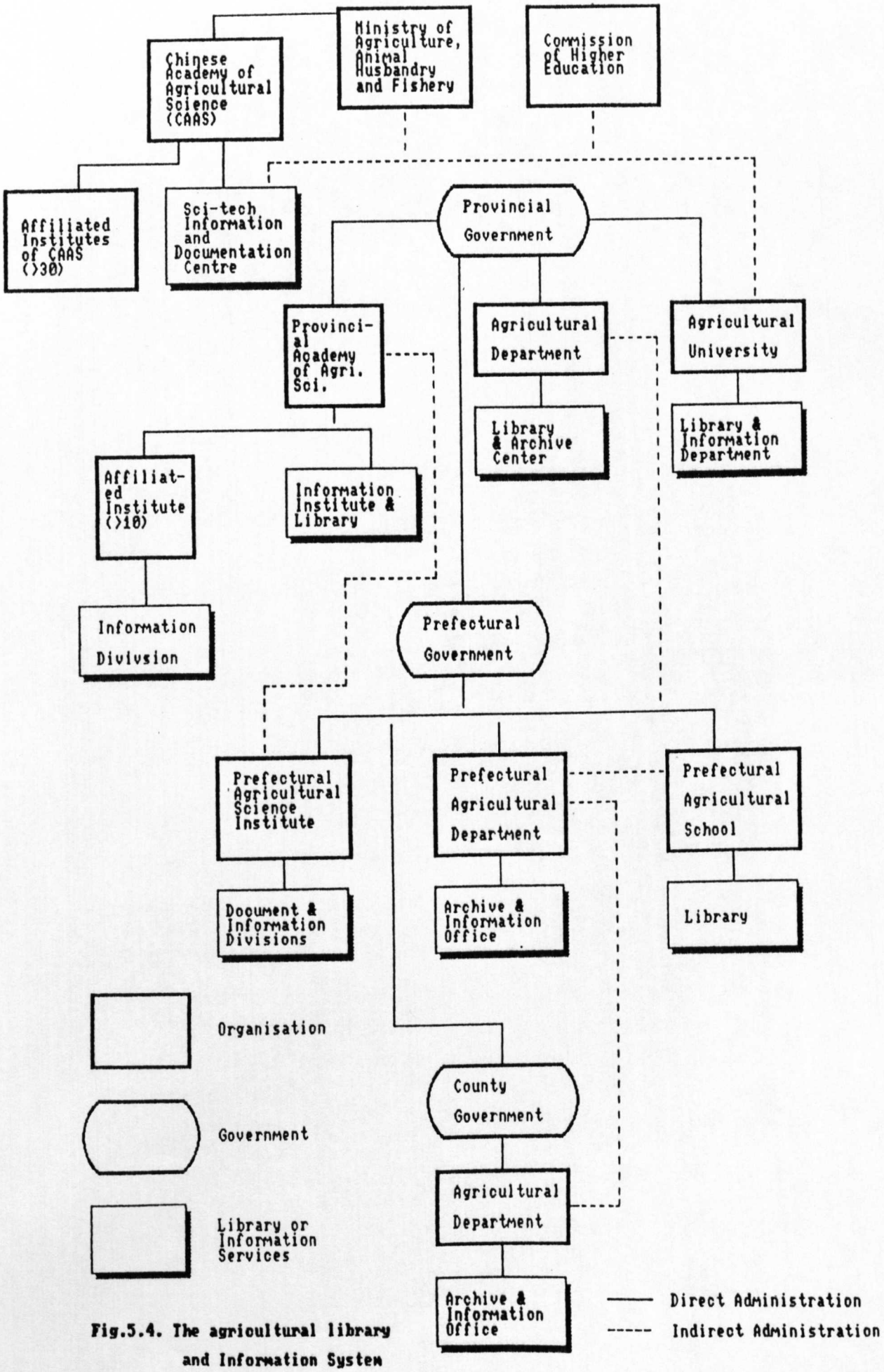


Fig.5.4. The agricultural library and Information System

With an overall view of the three levels, i.e. national, provincial and prefectural levels, most of the organisations falling into the categories of the above five sectors have established their own libraries and information divisions. In the research sector, most academies of agricultural science have founded institutes of sci-tech information since 1983. The libraries have become one part of the institutes. The establishment of institutes aims at expanding the services for the provision, processing, organisation and dissemination of information. In the education sector, there appears a different structure; an information office (division) has been fitted in most university libraries. The different structures chosen by those two sectors can be accounted for by their different service orientation and the user groups served. However, the libraries and information divisions in both sector are basically closed to outside. Meanwhile at county and village levels, there is a lack of such organisations. Therefore, the public libraries in the county are supposed to provide the major services for the users at these levels. However, due to the budget constraints, these public libraries are only able to acquire a small proportion of books on agriculture. Moreover most villages are remote and far from libraries. Thus it is rather difficult for those libraries to satisfy the needs of the biggest user group—farmers. To solve the problem, a lot of villages have set up small size reading rooms to meet the demand of farmers, and some public libraries lend their books to remote areas to ease access for users. Besides, technical extension stations have played a role in providing and disseminating information in the rural areas. But still how to provide more and better services to satisfy the needs of this group requires much attentions from the government.

5.4.3 Agricultural Information Resource in China

If we have a close look at the present state of coverage, distribution and utilisation of agricultural information resources, we should feel the urgency of speeding up the development of agricultural library and information network with a unified goal of collection development.

The following problems have been identified:

1. Low total coverage of information resources;
2. High degree of unnecessary duplication and serious budget wasting;
3. Over-concentration of agricultural information resources in big cities, and in universities and research institutions at national and provincial levels, but serious shortage of information resources at county level;
4. Bias towards the development of information resources at research level at the cost of resources at a practical level; and
5. The backwardness of the information industry and low utilisation of information resources. (Zhang, 1990)

Coverage

Generally speaking, the total coverage of information resources in China has increased a great deal in the course of the last decades. But if comparing the following 1) information coverage in advanced countries, 2) China's own population size (its potential users), and 3) its ultimate goal of modernisation in agriculture, the present coverage is rather insufficient, especially in foreign collection. It is estimated that total coverage of documentation places beyond the average level in the world.

We can look at the subscription to foreign periodicals. It has been estimated that there are around 8,000 periodicals relevant to agricultural science published in the world annually, which occupy around 16 per cent of the total output of periodicals regardless of subject. According to a rough calculation from the *Chinese Union Catalogue of Subscription of Foreign Periodicals and Newspapers* in 1982, the whole country subscribed 18,000 foreign periodicals, of which around 1,200 are relevant to agriculture. This amount of foreign periodicals is only 16.7 per cent of the world output of periodicals on agriculture. Being a national documentation centre on agriculture, the library of the Chinese Academy of Agricultural Science (CAAS), now renamed as Sci-tech Documentation and Information Centre of CAAS, with a stock of 3,500,000 books, subscribes only to 2,000 foreign periodicals. (Jin & Wang, 1987)

Duplication Degree

The degree of duplication is quite high if we compare it with the total resources available. This phenomenon is caused by the fact that development of libraries and information services is controlled by different administrative systems. Therefore, the libraries and information services have paid attention only to building up their libraries into so-called "Big-and-Complete" or "Small-but-Comprehensive" ones without an overall view of the development of information resources for whole areas, not to mention the whole country;

Again we can look at duplication of foreign journals. According to a national scale survey made by Jiang (1984), the agricultural libraries in the Beijing area subscribed to 836 foreign periodicals of the 1,000 aquired by the whole country. The total number of duplicated copies is 216, accounting for 20% --. The question is how to make a trade-off between introducing more varieties and purchasing more duplicated copies within limited budgets. Such a trade-off is difficult to make even in a local area, not to mention nation-wide, if we do not have a co-ordinating body engaged on a programme of co-operative or centralised acquisition.

Distribution (Allocation)

As we know, there are various factors which influence the collection size of documentation in an area. The following factors predominate: 1) the level of development in culture, science and technology, and 2) the consciousness of people about sci-tech information. In China, for various historical reasons, the level of culture, and of science and technology, is higher in coastal areas than that inland, and higher in Eastern areas than Western areas. Therefore,

taking an overall view, the agricultural information resources on the South East Coast are more adequate; middle-sized and big cities possess more information resources than small cities and towns; Large libraries and information services in the same area own bigger stocks; and libraries and information centres in the Education and Research sector usually have a bigger collection than those in other sectors. It is quite an interesting phenomenon that the Bradford Distribution can also describe the distribution of information resources among the libraries in China. It has been estimated that 60 per cent foreign books are concentrated in 2 per cent of libraries.

Utilisation

A more meaningful measure to evaluate the social effects of a documentation service is not the collection size but the utilisation of stocks by users. Low utilisation of documentation, especially that of foreign documentation, is a common problem in the libraries in China, and in the world as well. An investigation into the borrowing habits of more than one thousand teachers and students was carried out in North-western Agricultural University in China (Chen, 1986). The result has shown that the average annual circulation of documents on all subjects in western languages, Russian and Japanese is 6.4, 1.7 and 3.7 per cent respectively. The circulations of the books on agriculture and forestry are 7.25 per cent (western languages), 1.4 per cent (Russian) and 4.2 per cent (Japanese). Here the circulation rates were calculated without distinguishing duplicated copies. The circulation rates would be even lower if they were calculated for unique titles.

The causes of low utilisation of information resources are various. The following can be counted major causes: 1) potential users not being conscious of the existence of certain information; 2) lack of effectiveness in the information services; 3) lack of co-operation and resource-sharing between information services; and 4) uneven development of information resource in different areas.

As we know, the main aims of an information service are to enhance the utilisation of information resources by various types of users and to be able to provide all necessary information for every specific information need. In this way, it is able to show that information becomes even more socially and economically valuable in such a Documentation-User-Documentation multi-cycle. To meet such an end, the agricultural libraries and information services in China have much to catch up on and many efforts to make.

5.4.4 Dissemination of Agricultural Information in China

According to the estimation by CAB (Commonwealth Agricultural Bureaux) in 1984, the annual world production of agricultural documents is 300,000 items, and sci-tech periodicals 80,000 titles. In China, it was estimated that up to 1985 the total number of agricultural documents was over 500,000 and the average annual growth rate was 50,000. (Zhu & Lin, 1987)

A typical indicator of information dissemination can be found in the publication of periodicals. Here a set of statistical data collected by Jiang and his library (JAUL, 1979) is reproduced so that a general picture of the output of Chinese agricultural periodicals can be seen. The data disclose the total number of agricultural periodicals, their distribution over different subjects Table 5.6, and the category distribution of periodicals publishers from 1969 to 1978. (Table 5.7) etc.

Table 5.6: Distribution of Agricultural Periodicals in different subjects

Subject	Number
General	985
Agricultural Economy	9
Agricultural Basic Science	50
Agricultural Engineering	486
Agronomy	10
Plant Protection	62
Crops	103
Horticulture	63
Forestry	264
Animal Husbandry & Veterinary Silk-worm, Bees & Hunting	166
Fishery	93
Total	2,291

From Table 5.6., we can see, in decreasing numbers, General (985), Agricultural Engineering (486) to Agricultural Economy (9). From Table 5.7., we can see clearly that agricultural research institutes have performed the major roles in the dissemination of agricultural sci-tech information.

The agricultural administrative organisations and agricultural universities and schools contribute the same number of title, and therefore co-rank second. This is because China's information system follows a self-imposed discipline-orientated research mode. Two factors have been contributing to the bias: 1) the long-term policy of self- reliance, leading to enumerous duplicated efforts in scientific research; and 2) the influence of the Soviet model which manifestly stressed scientific communication and information.

Strictly speaking, the data disclosed above is quite out- of-date since it was estimated around a decade ago. It is noticeable that the orientation of agricultural publication has been altered in order to keep up with the changes in agricultural research, production, education and marketing etc since then. Practical and technical information showing an immediate economic effect, has attracted more attention.

It is worth noting that a high proportion, say around 80 per cent of the 2,291 periodicals are disseminated internally (Wu, 1984). The characteristics of "Internal Publication" has been explained in a preceding section.

With the increase of primary literature on agriculture, there was a strong need for effective retrieval tools to locate the literature. It was estimated that 56 types of secondary source have been produced by agricultural sci- tech services (Table 5.8).

Again, a large number of them are translation-oriented.

The history of Agricultural Sci-Tech secondary sources in China can be roughly divided into four stages:

1. 1956-1965 Original Stage
2. 1966-1976 Destructive Stage
3. 1977-1980 Recovery Stage
4. 1981-1988 Prosperous Stage

However, compared with some advanced countries, the abstracting and indexing services on Agriculture in China are still left behind. The following figures give us a picture of the giant producers of agricultural abstract journals in the world. CAB publishes 45 abstract journals, and items covered have reached over 15×10^5 annually; BA (USA) records more than 18×10^5 items per year.; both collect the documents published in over 100 countries. The abstracting services in China are still a developing area, especially in the processing of domestic agricultural information. The annual coverage of Chinese agricultural abstract journals is less than 4×10^5. And the time-lag is quite severe (Zhu & Lin, 1987). It is obvious that the services could not meet the demand of information retrieval for comprehensive, complete and up-to-date information. However, it is not expected that such giant abstracting services as CAB and BA will appear in China since they are not only costly but also wasteful in terms of the duplication of effort. It is desirable that the Chinese abstracting services focus on domestic literature and provide a good supplement to the world agricultural abstracting services.

5.4.5 Agricultural Information Retrieval System in China

At present, manual information retrieval (IR) still predominates in China and this will remain the case for some time since the potential computerisation of IR has been hindered by economic and technological constraints.(Chen, 1986). Nevertheless the establishment of computerised IR systems has become an important item in the national "Seventh-five Plan". Initial preparation for computerised information retrieval in China began as early as 1975. Since 1980, China has been importing foreign bibliographic databases in tape form as well as computers of various sizes for the purpose of exploration and experimentation. By 1985, China had imported over 70 foreign databases, running in approximately 30 computing centres, and providing both online and batch services to the scientific community. In the field of agriculture, several databases, such as CAB, BIOSIS, AGRICOLA and AGRIS have been imported. CAB tapes were brought in, in exchange for Chinese Abstracts. It has been planned that by 1990 China will import entire CAB databases. Beside batch services from

Table 5.7: No. of Agricultural Periodicals Published by Different Organisational Sector

Organisational Sector	No.	Organisational Sector	No.
Agri. Research	1,514	**Agri. Education**	262
of which		of which	
National	117	High Education	163
Provincial, Municipal, Autonomous	579	**Agri. Production**	
Prefectural, City	626	Farms	91
County	184	**Sci-tech Info Service**	107
Village	8	of which	
Agri. Administration	262	National	10
of which		Provincial, Municipal, Autonomous	46
National	6	Prefectural, City	42
Provincial, Municipal, Autonomous	46	County	9
Prefectural, City	84	**Information Network**	88
County	73	others	21
		Total	2,291

Table 5.8: Agricultural Secondary Sources in China (1985)

Category	No.	Items covered	No. of copies Distribute
Informative Journals	56	11×10^5	10×10^6
Abstract Journals	26	35,629	633,098
Index Journals	2	65,800	12,036

the tapes for SDI and RS, users have been able to access CAB hosted by DIALOG online in China since 1985. Other important preparations for a computerised agricultural IR system can be seen in the following work: Since 1975, the Sci-tech Information Institute of the CAAS, (now, STDIC-CAAS) has been involved in the compilation of Agricultural section of the *Chinese Thesaurus of Subject Terms.* Compiled by the joint effort of 1,300 experts from more than 500 information units and libraries, this work is the first national standard thesaurus in China. It was designed as a general working vocabulary in all fields of science and technology covering broad subject topic for the Chinese library and information network. Based on the above work, a subject thesaurus, *Agricultural Thesaurus of Subject Terms* has been compiled through the expansion and modification of the Agricultural Section. The above preparations plus further efforts have provided the necessary conditions to stimulate the development of a Chinese Character Processing system including both hardware and software, and the setting-up of a computerised agricultural information retrieval system. (He & Luo, 1987)

Besides, another important step has been taken to speed up the development of a computerised IR System, that is, the plan to establish AGRIS centres and sub-centres in China. In 1986, FAO and the Chinese Government planned to make use of Canadian (IDRC) investment to set up a national computerised AGRIS centre and seven AGRIS sub-centres. They organised a tour of investigators to go around the country and choose ideal sites as sub-centres. The Chinese government in consultation with the group of investigators determined that the configuration of the national AGRIS information retrieval system will be a composite star (Wang, 1985). The relationships between provincial centres, regional centres and the national centre are hierarchical or affiliated while the relationships between provincial centres and between regional centres are parallel. This complicated mixture has created good conditions for stimulating agricultural information resource-sharing and makes the idea of centralised cataloguing more practical.

We should be optimistic about the future development of the National Agricultural Information Retrieval System and certain regional systems after we have seen the preparations mentioned above. Moreover, IR in China has attracted more initial attention than did library automation, with more equipment as well as financial and staff support. And the situation will probably continue. The great importance attached to IR can be seen in the Overall Plan for the Establishment of an Agricultural Computerised Information Retrieval System.

5.4.6 Co-operation between Agricultural Libraries and Information Centres in China

As is the case for other library and information systems in China, the agricultural library and information systems are now conscious that networking and other forms of resource sharing are effective ways of providing economic relief and of improving library effectiveness. At some agricultural libraries and information centres, ILL Programmes have been carried out. The interlibrary loan requests arising are usually satisfied either by mail or by users themselves visiting the resource libraries (moving material around and moving people around). Some location information — union catalogues or union lists have been compiled through the joint

efforts of staff from different agricultural libraries and information centres. One example is the *Union List of Foreign Agricultural Periodicals Subscribed*, which covers the items from 94 agricultural libraries nation-wide. Some co-operative acquisition programmes are carried out to allocate some highly specialised, or rare, or expensive items; As a subsystem of national sci-tech information retrieval system, the agricultural information retrieval system has been put on the agenda of the government's Seventh-five year plan etc.

One fairly established co-operative activity is the exchange of material among libraries and information centres. The materials to be exchanged fall into the category of "internal publications", which are usually shelved in special reading rooms. The scale of exchanges varies among libraries and information centres since the exchange is on the basis of libraries' own choices and decisions.

Nevertheless, taking a critical view towards the present situation of co-operation, resource-sharing and networking, we can also find:

1. A lack of formal organisation, policies, commitment and standards—the existing co-operations are mainly based on a voluntary basis, therefore subject to easy cancellation;
2. Only small scale co-operation exercised in terms of geographical areas, organisation types, and co-operative functions.

The above evaluation of the present states in China's Agricultural Library and Information System takes an overall view on the systems as a whole without going to the details of the types of libraries and information centres, and types of user groups. The identification and assessment of potential participating libraries and identification of users' needs and behaviours are all essential investigation and analysis before the actual practice of design and planning. The following section is to meet this end.

5.5 Types of Agricultural Libraries and Information Services and Their Users

As mentioned earlier, in China agricultural libraries and information services fall into five categories: research, education, administration, production and other sectors.

Besides, there are some other relevant libraries and information services which provide agricultural information. Among them are the public libraries, institutes of sci-tech information, and some non- agricultural universities which do have departments of agriculture and relevant subjects.

Under following headings, the author will discuss the status of development, the orientation of services, the contribution of agricultural information provision and dissemination, the users and the need of users in different sectors.

5.5.1 Research Sector

Research and special libraries in China have developed alongside of scientific research and subject orientation. They are intended to satisfy research demand from their parent bodies. Their main tasks are to collect, process, store and retrieve information widely and provide both foreign and domestic sci-tech information effectively to their users. However, libraries of this sector have different focuses, orientations and responsibilities related to their administrative levels, specialisations and geographical locations etc.

National Centre of Agricultural Libraries and Information Services

As a national centre, the Sci-tech Documentation and Information Centre of CAAS (STDIC-CAAS) is responsible for comprehensively acquiring, processing and reporting both foreign and domestic information on Agriculture and Agricultural related subjects. It is intended to be a solid back-up for other lower-level agricultural libraries and information centres. It was established by the mergence of three units, i.e. the Library, the Institute of Sci-tech Information of the CAAS and the National Agricultural Publishing House in 1987. The library itself was founded as early as 1957. The newly-established centre is expect to perform all the roles that the previous three units used to perform plus some new roles—minus the overlap of functions and waste of resources. (vide Annexe 5.2.)

The Chinese Academy of Agricultural Science is composed of 30 specialised Research Institutes, of which about 10 are located next door to the centre of Beijing while the rest are spread in more than 10 provinces. The location of these specialised institutes was decided on the basis that research institutes should be near to the main production areas. Those situated in Beijing are mainly basic science oriented or comprehensive subject oriented. Those institutes that have easy access to the centre, therefore, became the main patrons of the centre. Most of them, however, have established their own small scale reading rooms stocked with key reference books and core journals in their fields for even easier access to the information needed. Additionally, they have set up a stock of internal publications and research archives for researchers to consult. Those located in the other provinces have to build up relatively bigger collections for their own users due to the geographical constraints. These libraries are usually characterised as highly specialised and compact ones. Their parent bodies, as affiliated institutes of the National Academy of Agricultural Science, are usually obliged to contribute their fruitful research achievements to promote production nation-wide. However, the areas where the institutes are located are benefited most from such research achievements. Similarly, their information divisions or libraries are the main contributors of agricultural Sci-tech information resources and disseminators of information in the local areas.

Overall, documentation and information work have been improved a great deal in the specialised institutes. But the present situation is still far from being satisfactory. There is a big gap to fill in order that the institutes become centres of information services and co-ordinating organisations in their subject fields. Under the unified plan by CAAS, the information divisions and libraries in the specialised institutes, should be in charge of provision, processing, storing, retrieving, dissemination and publishing of the specialised information, thus to pro-

mote the research and production in their own fields.

To sum up, the STDIC-CAAS, and the sci-tech information divisions containing libraries in the specialised research institutes are non-profit-making information services. Among these information services, there exists some co-operations co-ordinated by STDIC-CAAS. For instance, among these information services the idea of CA has been adopted in the subscription to foreign journals. A co-ordinating office is in charge of allocating the quota to those information services. Besides, STDIC-CAAS, more specifically the Agricultural Library Association and Agricultural Sci-tech Information Association have played an important role of co-ordinating libraries and information divisions nation-wide irrespective of the sectors. How these two associations function will be discussed later.

Institutes of Sci-tech Information in Provincial Academy of Agricultural Science

Each of the 29 provincial academies of agricultural science have established their own institute of sci-tech information since 1980. In most cases, the libraries are one part of the institutes which performs the role of collecting and circulating bibliographic resources, such as books and journals on agriculture and relevant subjects. However, the libraries had been established long before the establishment of the institutes. The establishment of institutes aims at expanding the services relating to the provision, processing, organisation and dissemination of information, while libraries seem incapable of coping well any more.

Most of the provincial Academies of Agricultural Science are affiliated with more than ten research institutes, which cover broad fields of agricultural science. Therefore, the libraries have developed into comprehensive agricultural libraries.

Similar to the role of STDIC-CAAS, the institutes of sci- tech information in provincial academies are naturally the strongest candidates to be centres of agricultural sci-tech documentation and information for the whole province.

Information and Document Divisions in Prefectural Agricultural Research Institutes

Under the administration of the prefectural governments, the agricultural research institutes are the core of the agricultural research in such huge areas that around six to seven counties are included. Therefore, the research institutes are expected to play very important roles in facilitating agricultural research, production and technological extension in the local area. Their information services seem not developed enough to match and support the roles well. Improvement should be made.

Types of Users in Research Sector

A. Researchers

It is obvious that researchers are the main type of user in this sector. The degree of their academic level is directly related to the research level and the completion of the research projects in their research institutes. This group of users can be divided into three sub-groups: 1) senior researchers, 2) middle level researchers, and 3) junior researchers, who show some different needs and patterns of behaviour from each other.

Generally speaking, researchers demand up-to-date, theoretical and high-level information. They usually have a higher capability of digesting sophisticated academic information and foreign materials. The capacity of absorption depends on the intellectual levels, experience of research and knowledge of foreign languages.

Senior Researchers are a minority among the researchers. Most of them are well-known scientists in their field or leaders of the projects. They usually have high academic and foreign language levels. They are usually able to obtain quite complete information about the developmental trend in their own field via informal channels, such as personal correspondence and conferences etc.

Middle-level Researchers, i.e. Assistant Researchers are the majority among researchers. And they usually play a very important role as a backbone to the research, they form a connection between Senior and Junior Researchers. Most of them take charge of certain research projects. Corresponding with the different stages of the research and seasons of agricultural production, their information needs appear as periodic characteristics. In recent years, with the execution of "Star-plan" and with the introduction of science and technology in rural areas, they are the most active group to go to rural areas and carry out research there. Their information needs have expanded from single subject to multiple subjects and from sci-tech research information to technical and practical information.

Junior Researchers, i.e. Research Assistants are the reserve force of the research. They are usually engaged in assistance work for the research. They demand basic works on the subject by which they can improve their subject knowledge.

B. Non-researchers (including administrators and technicians)

Different from researchers, most of them demand information for their sociological or leisure interests.

5.5.2 Education Sector

In this sector, there are two main types, i.e. agricultural universities or college (High Education), and agricultural schools (vocational schools—middle school level). Nation-wide, almost each province has established one or two agricultural universities or agriculture related universities, over 70 nation-wide, of which some have a long history and some are the recent result of an emphasis on both education and agriculture modernisation. As far as the agricultural schools are concerned, most of them are distributed in prefectures. It has been realised that agricultural science and technology are the key to fulfilling the objective

of agricultural modernisation. Therefore, the imparting of sci-tech knowledge and training of qualified technical personnel become imperative. Besides, some schools and colleges are devoted to training agricultural administrative personnel. These are usually named agricultural management schools or colleges. Students are from agricultural management personnel at different levels, especially the production fronts. These schools and colleges are more or less on-job training.

The libraries, as academic information services, are an important component part of teaching and research at universities and schools. They are the "second lecture room" which also imparts sci-tech knowledge to the students.

Libraries in the Agricultural Universities

There are around 6-8 key Agricultural Universities under the direction of the Ministry of Agriculture, Animal Husbandry and Fishery. Most other agricultural universities and colleges are administered by relevant governmental education departments but they obtain the technical supervisions from both the agricultural and cultural departments of the provincial governments. Libraries of universities or colleges are usually under the direction of deputy principals. Generally speaking, agricultural university and college libraries have been stocked with larger collections than other sectors.

To satisfy the increased demand from farmers, the agricultural universities have started to run various kinds of training courses for farmers, which therefore create some demand for more technical and practical information. It is important for agricultural university libraries to adjust themselves to present circumstances and expand their services to various users.

As an important part of provincial sci-tech information centre, agricultural university library and information divisions provide information services mainly for education, research and technological extension. They should exert their privileges and develop themselves into a training centres for the staff of agricultural sci-tech information services and libraries.

Libraries at Agricultural Schools

In order to popularise agricultural education, more and more agricultural schools have been established to supplement agricultural universities. Most of them are administered by both the prefectural government and the agricultural departments of provincial governments. Most agricultural schools are more specialised, if compared with agricultural universities. Their specialities are largely related to the characteristics of agricultural production in the areas. Moreover, agricultural schools impart more practical and elementary knowledge to the students and train them to be technical personnel. The graduates are more suited to work in the technological extension and production front. In most cases, the libraries in agricultural schools have the biggest agricultural collections in their prefectures. It is necessary to change the way in which the libraries provide services (mainly to their own teachers and students) so that the information resourcess will exert more effect on agricultural production, education,

Table 5.9: Comparison of Two Sectors

Characteristics	Research Sector	Education
SUBJECT	more comprehensive	more specialised
USERS	more	less
COLLECTION		
Basic Science	more	less
Non-agri. Books	more	less
Duplicated Copies	more	less

decision-making and marketing in the locality etc.

Generally speaking, agricultural universities and agricultural schools have bigger library stocks than agricultural research at parallel levels. This phenomenon is caused by their different characteristics and other factors. Comparisons can be made to explain the phenomenon (Table 5.9).

Types of Users in Education Sector

A. Students

Students can be divided into two major groups, undergraduate and postgraduate students. Undergraduate students (including students in agricultural schools) are the majority of the users at agricultural university. Most of them use the library as their "second class-room" to help themselves understand more about the context of the lectures and supplement their knowledge about the subjects. They are usually not very good at finding out the information they need. Therefore, the libraries have the duty to give them necessary guideline about how to use the library. However, it is noticeable that a large number of undergraduate students treat the library as a "reading room" by reading only their own textbooks, especially during the examination period, which demand the libraries to expand their space for reading rooms. To satisfy this group of users the libraries usually purchase the basic science oriented collection and more duplicated copies.

Postgraduate Students are a group of users whose information needs are different from those of teachers, researchers and undergraduate students, but combine some characteristics of those three groups. They usually require information not only to increase their own knowledge and make themselves more capable as undergraduates usually do, but also need information on developmental trends and to aid the exploration of the unknown in a given subject, as teacher and researcher usually do.

B. Teachers

This group of users has the responsibility of imparting students with basic knowledge and training them into qualified sci-tech personnel. In order to prepare their lectures and compile textbooks, they usually need to refresh their own knowledge by reading up-to-date information. Moreover, most teachers hold research posts concurrently. Therefore, their information demands seem similar to those of researchers in research institutes. This group can also be divided into three sub-groups, those of professors, lecturers and teaching assistants.

The proportion of professors and associate professors among teachers varies much in different universities and departments in China. These users are usually outstanding in their respective fields. Similar to senior researchers, they have shown a great need for information covering research trends, new achievements and new theories etc. They usually obtain information via informal channels because of the existence of an Invisible College. They need a large amount of systematic, complete and up-to-date information about their fields of interests in order to write books about the theories and principles of the subjects concerned.

Lecturers usually undertake most of the teaching tasks at the universities. To prepare for their lectures, they usually have to be familiar with the textbooks and consult documents covering the basic theory of the subjects. Meanwhile they usually form the core of research groups in the particular fields of interest. In order to stand in the frontier of development in their fields, they need to be informed on newly disclosed research achievements in their fields. Nevertheless, these users suffer two types of pressure, i.e. time and language. Firstly, they are so overloaded by undertaking both teaching and research that they cannot find enough time to consult information. Secondly, for historical reasons, most of them have learnt Russian as their first foreign language, which gave them certain language barriers in such an English language-dominant Sci-tech world.

Teaching assistants are the reserve forces of the departments in both teaching and research. They are usually involved in some tutorial and demonstration work for students thus they are required to acquire some specific knowledge and laboratory skills. Thus, they need practical information to help prepare them to demonstrate particular techniques or machines. At the same time, they are eager to improve their subject knowledge by reading the basic works in the subjects.

Farmers in experimental farms of universities and schools are engaged in assisting experiments, research and technological extension to teachers and researchers. They are usually instructed what to do and how to do it by teachers and researchers. They usually need practical information to help them understand parts of experiments and pieces of researches.

5.5.3 Administration Sector

As the governmental departments, Agricultural Departments are usually in charge of policy-making, production and trend-reporting (for higher-level decision and policy-making), assessing research achievement and extension etc. in the field of agriculture.

In the departments, there are three divisions relating to the storage and provision of information. They are

1. Archival Offices;
2. Reference and Internal Publication divisions; and
3. Libraries etc.

Among them, the first, is in most cases the more important and well-established in the departments. This is due to the recognition of the important role of archive in governmental departments. Archival Offices are in charge of collecting, processing grey literature and government official documents, statistics from surveys, summaries, reports etc. Library and reference offices used to be services for leisure purposes. Since early 1980s, libraries have started to collect specialised sci-tech books and journals. However, they are faced with budget restrictions since a large proportion of funds for acquiring books and journals has been allocated to the individual divisions.

It has been demonstrated that there are three major information sources for the officers;

1. Government documents and grey literature (from central government or upper-level Governments);
2. Reports on the state of production; and
3. Trends of agricultural productions shown in both foreign and domestic literature, etc.

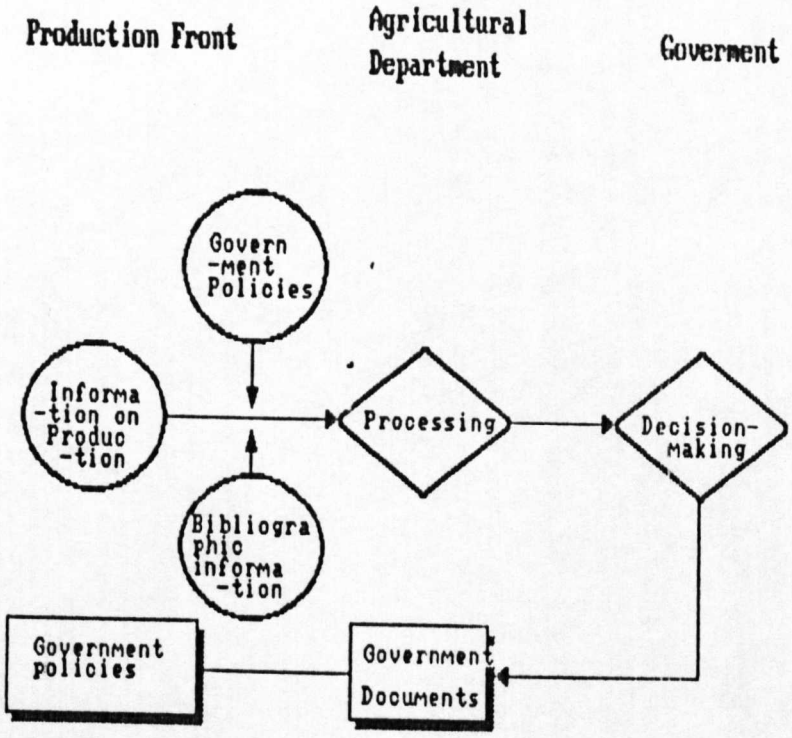
In most agricultural departments, information acquisition and storage have developed into their own patterns compared with that in the two sectors mentioned above. Generally speaking, each specialised divisions of the department has its own network and channel to acquire information needed. Furthermore, they have their own budgets for acquiring necessary reference books and core journals. Based on the information acquired, they process that information into reports containing reviews, assessments and strategic proposals about policies and plans for decision and policy-makers. Then those proposals become governmental policy documents after the approval and decision of the decision-makers. Finally, the document is disseminated to the production front. Figure 5.5 illustrates the process of information flow.

Whether the acquisition and storage of sci-tech books and journals should be in a more centralised mode or not has become an important issue. The arguments in favour of centralised acquisition and storage are stated as:

1. Centralised purchase can avoid unnecessary duplication and facilitate the resource-sharing;
2. Libraries are good at processing and organising bibliographic information. Therefore, centralised storage can make information more organised and easier to be retrieved.

The arguments against are:

Figure 5.5: Process of Information Flow in the Agricultural Departments



1. The divisions are usually highly specialised. The information acquired will not be too much duplicated by that acquired in the other divisions provided that there is some co-ordination in acquisition.

2. Officers are used to the immediate access to information in their own offices. The removal of such access will apparently cause much inconvenience to them.

The officers in the departments have either backgrounds in agriculture or management backgrounds. The nature of the work they involved in is either administrative or technical. However, generally speaking, those officers need a large quantity of up-to-date information on agricultural production and marketing so that they are able to provide both decision-making information to upper-level administrations and practical policies to production fronts, marketing and technological extension. They are the key figures who link upper-level administration, researchers, and teachers with the farmers and technological personnel in extension stations.

Due to their special administrative position, agricultural departments are ideal candidates for co-ordinating projects in the extending agricultural research achievements. It is also expected that they can play an important role in co-ordinating agricultural libraries and information services in their corresponding geographical areas. For example a provincial agricultural department should be one of the key organisations which is in charge of the development of agricultural libraries and information networks across province. Unfortunately, it seems that not enough attention has been paid to the development of library and information systems by the administrators in the agricultural departments. Proposals on the establishment of

agricultural libraries and information networks can be heard, but not many steps towards planning and implementing them have been taken yet.

5.5.4 Production Sector

This sector includes two major groups: 1) state-run farms (varying from large-scale to small-scale, from comprehensive to specialised); and 2) peasant-run farms (varying from group-run to family-run).

It is noticeable that the governmental agricultural departments have direct or indirect administrative relationship with this sector. It is these departments that decide the policies for production, technological extension, resources allocation and investment in the state-run farms.

The vast majority of personnel in this sector are farmers. They are directly engaged in agricultural production including crop production, animal husbandry, fishery and forestry production etc. The other personnel are technological and administrative. All of them aim to improve the yield and quality of agricultural products. Therefore, they are expecting the introduction of the following:

1. Desirable varieties with high yield, high quality and high resistance to diseases, pests and bad weather;
2. Highly efficient fertilisers and pesticides;
3. Improved techniques and good experiences of cultivation and plant protection
4. Modern machinery and tools for labour-saving, and
5. The processing, storage and sale of new side products etc.

To satisfy those wants, the three sectors mentioned above have co-operated with the farms to a certain extent. Some effective ways of introducing of new technologies have been adopted. Among them, demonstration—plots or farms experimenting with new technologies and broadcasting programmes are highly recommended.

Libraries and other information services, however, in this sector are the least developed in China. In state-run farms, the libraries are usually small with insufficient resourcess, in terms of collection, money and man power. There is a great lack of information services in the rural areas. And the present services are no longer able to meet the growing information needs stimulated by present policies and the present system, i.e. group responsibility and individual responsibility production pattern. The nearest points of access to comparatively bigger collections are county public libraries and information services in county agricultural departments, and technological extension stations etc. But unfortunately, county public libraries are usually only stocked with a small proportion of agricultural books. To remote farmers, it is still too far if they have to go to the town to borrow books. To solve the problems faced in

the making information accessible to the farmers, the three information services mentioned have tried various ways. The following steps have been taken by some of them (Jiang, 1987):

1. Setting up reading-rooms in the farms or villages;
2. Organising mobile libraries stocked with books from county public libraries;
3. Carrying out surveys on the information needs of key and specialised house-hold farms, and compiling special files for them, then supplying SDI information services to them;
4. Compiling agricultural information newsletters and broadcasting programmes to introduce new varieties, new techniques and so on;
5. Organising meetings for disclosing specialised technical information; and
6. Organising teams of information personnel to visit farms and providing consultancy services to put across the information needed, etc.

Farmers and technical personnels in State-run farms

The state-run farms are characterised by the main tasks they perform. Some state-run farms are production based for certain crops, i.e. production-oriented. Some of them, however, are the experimentally based for research and technical extension, i.e. experiment-oriented. The farmers in different groups show certain trends in their information needs. Generally speaking, the farmers demand practical information which can instruct them what to do and how to do it in the processing of crop planting. Apart from the live demonstration in the field, audio-visual transmitted information, i.e. broadcasting and video programmes is also an effective means of dissemination.

Besides farmers, there is a certain proportion of technical personnel on the farms. They are in charge of technical supervision to farmers, of technical problem-solving in the process of production, and of the transferring new techniques in production. This group needs practical information as well as some theoretical information to improve its knowledge and comprehension of the new technologies introduced. The administrative group on the other hands needs information about farm management, business and marketing so that they can run the farm well and market their products well.

Farmers of Specialised-Households and United Farms

This group of farmers is usually called peasants in China. As the reforms, such as output-related system of contractual responsibility, were carried out in the rural economy there emerged hundreds and thousands of specialised households and co-operative coalitions. These specialised households and united farms stimulate a heavy demand on the introduction of science and technology and increase the desire to study in the rural areas. This phenomenon is the one without parallel in history. Many farmers from those farms are young people, who have

been educated up to secondary school level. They believe that science and technology are the keys to the door of the wealth and prosperity. They need some practical and technical oriented information on crop-planting, stock breeding and food processing etc. They usually seek information by writing to experts directly or to local libraries. How to provide information services to them has become an important issue for local government, libraries and information services in its own sector and other sectors as well.

Generally speaking, however, farmers have the following characteristics, compared with the other groups:

1. Lower knowledge level in culture, science and technology and lower ability to absorb and comprehend information

   They usually have the difficulty in utilising academic papers, reports, patents, technical standards and technical journals.

2. Lack of consciousness to information

   Most of them have little idea where and how to gather information.

3. Weak foundation of economy

   They welcome the information which has a quick effect and a low cost. They cannot afford the loss caused by the wrong information, especially marketing information.

5.5.5 Others

Agricultural Technological Extension Centres and Stations

Agricultural technological extension centres and stations are special types of agricultural organisation, which play very important roles in the technology transferring process. Administratively, they are under the direction of agricultural departments. But they extend the research achievements from both agricultural research and education sectors. Therefore, they are closely related to agricultural research, education and production. The technological extension stations are usually scattered at the district level (immediately under the county level). The vast majority of the personnel in the technological extension stations are technical personnel, who are either university graduates or agricultural school graduates or trained technicians. Depending on the nature of the tasks they perform, they demand practical information and some theoretical information as well. It is noteworthy that they actually perform the roles of technological gatekeepers. It is they who have to understand more about the technologies introduced and then to instruct the farmers what to do and how to do. In most of cases, the technical personnel find it difficult to access the high-level academic information which they need to improve their knowledge and comprehension of new technologies, because of the long distances to big libraries.

Agricultural Sections in Public Libraries

Provincial public libraries usually have a big agricultural collection, to which limited access is provided to agricultural personnel in terms of borrowing. The agricultural personnel can access the libraries for the purpose of consulting references and reading books and journals by presenting his identification. But only a small number of borrowing cards has been issued and allocated, mainly to agricultural organisations. Having top priority in the province, provincial public libraries are usually responsible for co-ordinating and organising professional activities. Provincial central committees and provincial library associations have been established in almost every province. These two organisations are in charge of academic and professional activities, exchange of experiences, training programmes, and co-ordination and liaison between libraries throughout the province, irrespective of subject.

The city public libraries are usually only stocked with very slight agricultural collections since their main users are not related to agriculture.

County public libraries are the very fronts to the farmers. They used to be stocked with a larger proportion of agricultural collection. Under the pressure of tightened budgets for acquisition, most of them have cut down their budgets for agricultural collections. Such collections have been candidates for cuts due to their low utilisation rates. Some of them lend the existing collection to villages as mobile libraries. The county public libraries should be more aware of the increased information needs of farmers stimulated by the reform of the rural economy. What the libraries should provide is an effective and easy-to-access information service to the farmers.

Agricultural Divisions in Provincial & Prefectural Institutes of Sci-tech Information

The institutes of sci-tech information usually provide documentation services, information dissemination, information processing, storing and retrieving, information research and information consultancy covering all subjects.

In most cases, the provincial institutes are usually well stocked with technical reports, patent documentations, technical standards, sci-tech periodicals, display samples, sci-tech audio-visual media and MARC tapes etc. To match the services, they are usually equipped with modern facilities, such as computers, transmission facilities, video camera systems, micrographics systems, photocopying systems and electronic composition of printing systems etc.

Technical personnel throughout the province can access documentation services to consult the collections. But no borrowing services are provided.

The institutes are usually the only places where international information retrieval hosts may be accessed in the provinces at present. The implementation of the Seventh-five plan for the establishment of a national information retrieval network which links provincial and prefectural institutes will certainly be a breakthrough and a far-reaching event for users in

local areas.

Apart from the documentation and information retrieval services, the institutes usually carry out information research and consultancy. The information researches usually focuses on certain topics which may have a large impact on the development of science, technology and economy in the provinces. In the light of these topics, the researchers carry out literature reviews, investigations and surveys on the developmental trends on topics of interests and then write reports to the decision-makers. Meanwhile the information consultancy services cover the exploration of new products, new technologies, innovations and inventions, and marketing information etc. and provide translation services as well.

As well as information research topics and information consultancy, there are also a certain proportion of topics on agriculture and food processing etc.

Farm-run and Township Enterprise

Since the reform of the rural economy, the farm-run and township enterprise have appeared and developed rapidly. They have become an important mainstay of rural economy. These enterprises, however, have suffered from the lack of technical personnel and information, including technical information and marketing information. This impairs their further development and weakens their competitiveness. Today, in China the inherent philosophy has been shaken. Having realised the potential of those enterprises, many technical personnel quit the jobs with "Iron-Bowel"— stable jobs with guaranteed salaries and go to rural areas to take the "Clay-Bowel" jobs. Big agricultural libraries and information services have now also realised that the emergence of such enterprises has challenged the traditional means of information provision and subject orientation. The information which technical personnel, administrators and workers in the enterprises demand is that which is more technical and industrial and marketing-oriented. The information about new technologies, new processes and new products should be quickly disseminated through newspapers and as a form of current awareness and the reliability of the information, especially marketing information, is very important. Due to the special nature of these enterprises, i.e. their close relationships with both agriculture and industry, they require special management, policies and information provision.

As for management, bureaux (governmental departments) have been established for administration of these enterprises, from the level of central government to the level of county governments. These bureaux help the governments to make policies and decisions for the enterprises and to gain the feedback from them. As far as the information provision is concerned, a new type of library and information centre is taking shape to meet the special information demand from decision-makers, administrators, technical personnel and workers. Before such information services are well developed, agricultural libraries and information services at every level, are obligated to provide services to these groups of users. Their roles will not cease in the future because the enterprises are closely related to agriculture and they should be able to utilise and share the resourcess of agricultural libraries and information services.

The Agricultural Library Association and Agricultural Sci-tech Information Association

A. Agricultural Library Association

The Agricultural Library Association in China was established in 1983 after the recognition of the need to link agricultural libraries together to promote co-operation, exchanges of information, materials and experiences and to share resourcess among the agricultural libraries. It aims at performing the role of a co-ordinating body for various co-operative activities. Its members are assigned the following tasks (CALA, 1983):

1. Providing SDI services to facilitate agricultural education, research, and technological extension;
2. Compiling UC for agricultural bibliographic information and establishing a national IR system;
3. Carrying out ILL services, co-ordinating collection development and resource-sharing;
4. Planning and organising training programmes for both librarians and users;
5. Organising academic activities for experience-exchange and professional discussions;
6. Investigating the situation of agricultural libraries and making proposals for further development to higher administration;
7. Studying on the feasibility of computerisation in agricultural libraries, and facilitating the realisation of computerisation;
8. Compiling and publishing association publications;
9. Organising international exchanges and co-operations.

The libraries falling into the following categories are eligible participating members:

1. Libraries in Agricultural Universities;
2. Libraries in Research Institutes (Central and provincial levels)
3. Libraries in agricultural relevant organisations (Central and Provincial levels);

B. Agricultural Sci-tech Information Association

This was established to assume similar roles to the Library Association with emphasis on information work. It was the result of distinguishing information work from library work. Actually, its functions overlap with that of the library association, to some extent. There has been a plan to merge these two bodies.

How effectively these associations can co-ordinate those co-operative activities is in question since they are not executive and funding bodies. Complicated administrative relations may prevent them from being authoritative enough toward agricultural libraries at different levels and sectors. However, they have performed fairly well in organising professional conferences, seminars and training programmes.

5.5.6 Summary

The above discussion about different user groups, their information needs and behaviour, and performance of services for them can be summarised in Table 5.10.

Table 5.10: Summary of User Information Needs & Behaviour

Sectors	User Groups	Types of Info. Required Most	Awareness of Information	Utilisation Ability	Services Provided
R	Researcher -Senior -Middle -Junior	Sci-tech, Up-to-date Specialised, Academic Periodicals	High	Higher	Reasonably Good
	Non-researchers -Administrator -Technician -Others	Administrative Practical Leisure Sociological	Lower	Lower	Poor
E	Students -Undergraduate -Postgraduate	Sci-tech incorporated textbooks	High	Low	Reasonably Good
	Teachers -Professor -Lecturer -Teaching Assistant	Sci-tech Up-to-date Comprehensive Periodicals & textbooks	Higher	Higher	Good
	Others	Administrative Practical Leisure	Low		Poor
A	Decision -makers	Summarised Trend Reports	High	High	Poor
	Officers	Trend Info. on Agri, Research, Education & Production	High	High	Poor
P	Farmers -State-run -Private	Practical Info. Demonstrative Technologies Varieties etc.	Low	Very Low	Poor
	Technical Personnel -Extension Station -Farms	Practical Information	Low	Low	Poor

Part III

Core of the Study

Chapter 6

Overall Design

6.1 Introduction

Overall design here means the decisions about some design issues relevant to the network level, in terms of objectives, structures, and other design issues, irrespective of the details of the individual nodes and individual functions.

The importance, principles and procedures of the identification and determination of those issues will be given and the results will be presented and justified in the following sections.

6.2 Design Issues

6.2.1 Identification of Objectives

The design stage of the systems investigation demands that the analyst has a high-level of technical and conceptual skills. The major objectives for the new information system, as well as the sub-objectives for the operating and management information systems, must be identified to develop a unified set of goals. In addition, the systems analyst must have a thorough knowledge of the available data-processing equipment for the new information system. He/she also needs substantial expertise in recognising human constraints that will present during the implementation of any new information system. (Alexander, 1974)

The overall objective of the new information system may be simply a general statement of the aims and goals that it seeks to achieve. The old objective furnish an excellent starting point for developing the new one.

Examining the procedures in Fig.4.1, we can find that the identification of the network objectives comes first, which is usually the case. This is a crucial task to accomplish. It is obvious that the objectives, goals and policies of the central government for the development

of the economy, science, technology, culture and education, etc., will determine the motivation of the networking under Chinese circumstance. Therefore, the network will be assigned of certain high-level, long term and short term objectives, which should take into account: 1) the national objectives; 2) the need of users, and 3) the performance of individual nodes in attempting to satisfy the objectives.

In this project, the objectives which need to be determined are those overall network objectives and the objectives of individual functions at both high-level and low-level, and for both long-term and short-term. These form a hierarchy of objectives, in terms of level, and time span.

In this research, based on the review of general network objectives, Chinese circumstances, subject characteristics of agriculture and old system objectives, the author identifies the following as the high-level overall objectives for the network being designed:

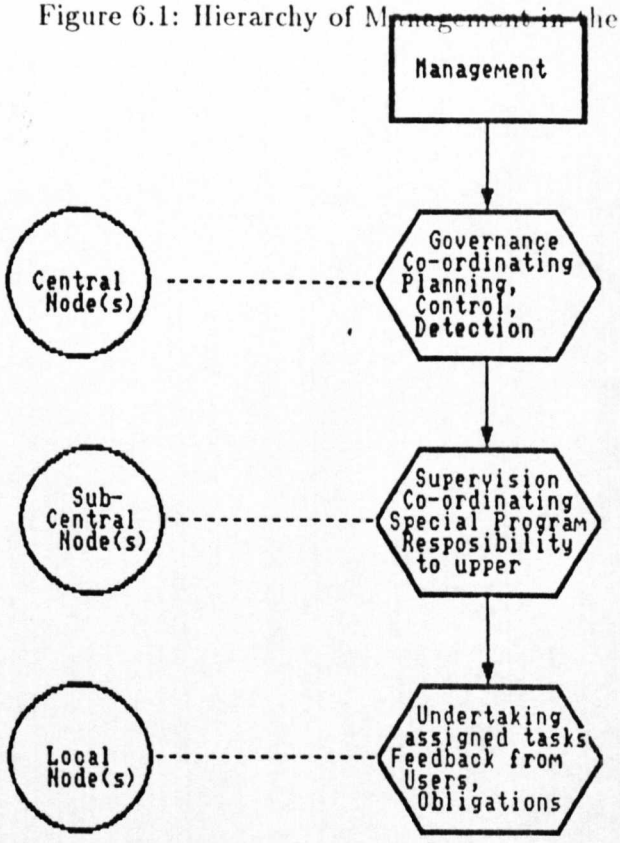
1. To relieve the budget difficulties in purchase of collection that exist in the individual libraries and information centres within the area or system being concerned.
2. To improve the effectiveness of those libraries and information centres;
3. To provide comprehensive, timely and cost-effective services to satisfy the various information needs of the different types of users in different geographical locations within the area concerned;
4. To provide effective information services that promote agricultural decision-making, research achievements, production level, education quality and marketing in the area concerned; and
5. To ensure that the agricultural information network fits into the overall plans of the central and local government.

The overall low-level objectives are usually functional oriented. Since the network being designed plans to carry out four main functions, i.e. CA, ILL-UC and IR, its low- level objectives should focus on those four functions. They can be formulated as follows:

1. To provide information services with reasonable accessibility and availability of information needed by various types of users identified;
2. To provide an ILL service with high fulfilled rate, low time delay and cost;
3. To establish cost-effective UC services for location information thus to facilitate effective ILL services and other services;
4. To provide IR services with highly relevant information, at low response time and costs.

Once the overall network objectives have been identified and agreed by the network members, every member is obligated to work towards the objectives.

Figure 6.1: Hierarchy of Management in the Network



The individual functions should have more specific objectives, which will be discussed in the succeeding three chapters. And apart from the overall objectives, there should be some sub-objectives for different types, levels of nodes and individual nodes to fulfil. Those sub-objectives should comply with the overall network objectives and overall network function objectives. And they usually vary in some aspects among the levels and types of nodes to reflect their own orientations in functions, services and responsibilities. In mathematical sense, the difference will be given different weights or prices. Thus an attempt to find out the differences in the objectives between the network and the individual nodes, and between different levels of nodes need to be made. Figure 6.1 shows the different roles which different levels of nodes can possibly play. It is helpful in setting up the sub-objectives.

It is apparent that some objectives cannot be quantified since they fall into social, behavioural, psychological and political categories.

The determination of quantifiable objectives should be based on the knowledge, the analysis of published source and the analysis of the situation investigated. That is to say, overall consideration of the standard (if there are some), the common objectives of the library and information systems, and the past and the present situation of the system to be designed should be taken at this stage. While quantification of objectives is the statement of an objective as a mathematical function of decision variables.

6.2.2 Identification of Nodes, Links and Resources

As the author mentioned before, the types of China's Agricultural Library and Information Centre can mainly be classified into five sectors. And a further identification is necessary to make under each sector. Chapter five made such an attempt.

As for the administrative relationship between those libraries or information services, the link within the sector is more or less hierarchical. But there are almost no direct adminitrative links between the sectors, except the links between government departments with some of others.

Viewing existing co-operation, we can see that some links exist across the sectors. Generally speaking, there are more links between sectors at the same levels, or in the same areas than that at different levels or in the different areas.

Identification of the potential nodes are based on the following: (1) Published Statistics, (2) Surveys and (3) Knowledges. For example, in the case of Zhejiang province, published statistics of agricultural research institutes and public libraries were found during data collection. And information about others was gathered by visiting government departments' archive offices. Therefore, 28 major agricultural libraries and information services were identified, which excludes public libraries lower than provincial level and agricultural libraries lower than county level. Public libraries are regarded as an aggregated back-up with the representatives of provincial library. The choice of 28 libraries aims at convenience of data collection, data analysis and model testing. The county level agricultural libraries are aggregated and attached with prefectural agricultural libraries. The existing stock of county level agricultural libraries contribute a small proportion to the whole network being designed. But the future allocation should reflect the importance of those libraries in serving the largest potential user groups—farmers. More investment from the government is needed to develop the services at these low levels.

It was realised that identification and evaluation of resources—physical, human, financial, and other—that are potentially available to meet the objectives are vital in the design of networks. Therefore, during the survey, attempts to assess the resources of those libraries were made, which will be discussed in more details in Chapter Eleven.

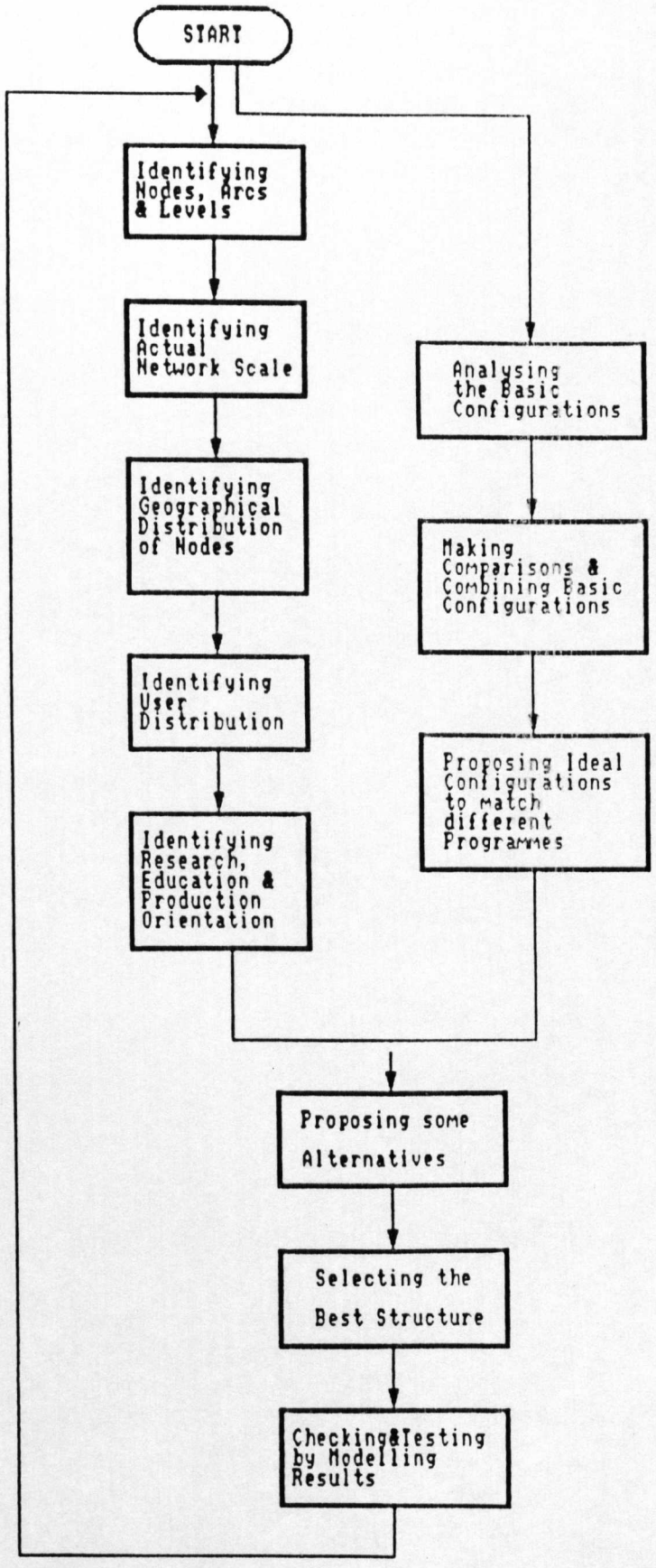
6.2.3 Determination of Network Structure

The determination of the structure of network can follow such procedures (Figure 6.2).

Basic Configurations

As mentioned in Chapter One, the most frequently mentioned configurations are (a) star, (b) ring, (c) hierarchical, and (d) distributed.

Figure 6.2: Procedures of Determining the Structure of the Network



Existing Situations

Examining the organisational structure of China's Agricultural library and information systems (Chapter Five), we can find that it is more or less hierarchical but not rigidly hierarchical. The existing patterns of those co-operation activities are lack of structure since the co-operations are informal and on a voluntary basis. But most likely, the libraries will co-operate more with the libraries in the same sectors-vertical system than with those in different sectors. The libraries in the same sector usually have similar characteristics, and it is more convenient to access one another.

Technologies applied

The technology employed seems to be related to the structure of the network. Decentralised networks use low-level communications technology such as TWX, hierarchical structured networks use the telephone systems with people interacting at each level; while centralised systems tend to use high-level of technology such as large computers (Williams & Flynn, 1978). However, the application of microcomputer tends to favour decentralised structure. Keep in mind that many library and information network—computerised or non-computerised—tend to have variety of configurations in one system. They may be centralised in one aspect and decentralised, hierarchical, or mixed in others.

Determination of Configuration for Management

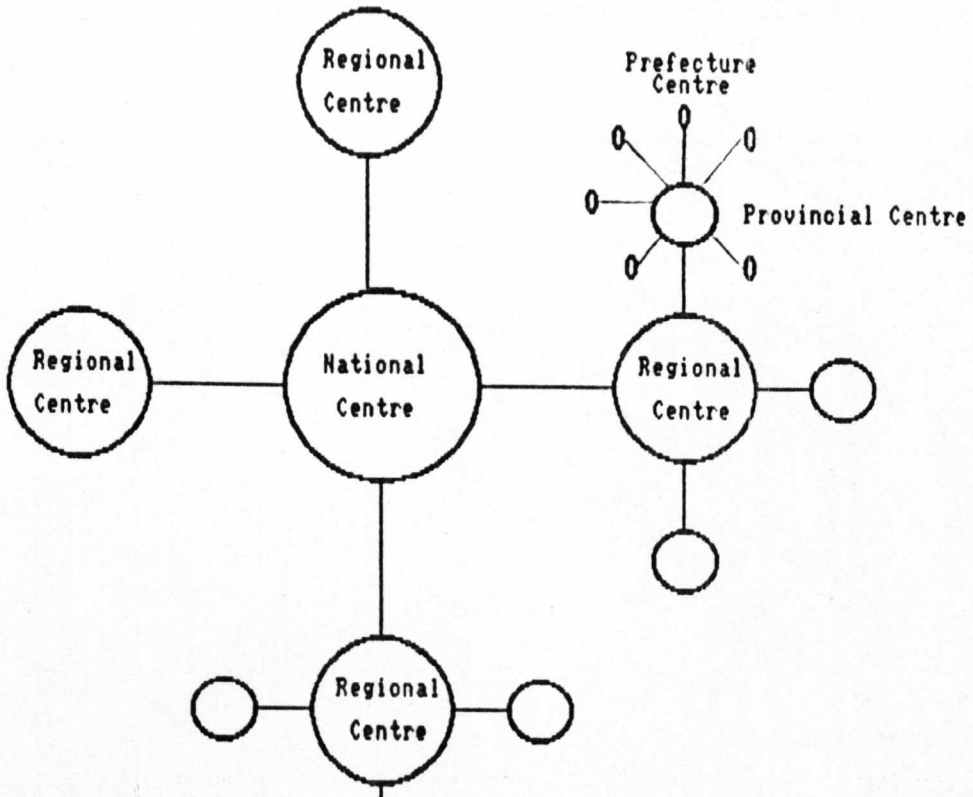
The configurations for the particular functions to match alternatives programmes will be determined by a careful descriptive analysis, which will be discussed in the design of those functions. If we take ILL function as an example, we can find that ILL systems can be configurated in different ways. Whether hierarchical, centralised or distributed configuration suits better to Program One, or Program Two or Program Three should take consideration of (a) present situation, (b) cost-effectiveness and (c) possible modes in which the ILL system can be run.

Following the procedures, and having a thorough analysis of the factors related to the determination, here, the author can propose that the configuration of China's Agricultural Library and information network should be composite star, in terms of management. It can be illustrated in Figure 6.3.

Determination of Configurations for Alternative Programmes

Alternatives programmes here refer to the alternative technologies to be applied in the network, more specifically network functions. The alternative programme will be defined in a later section. The determination, therefore, should be placed in that section. But bearing in mind, once we have clearly identified and defined the different programmes, i.e. non-

Figure 6.3: Configuration of China's Agricultural Library & Information System



computerised, or computerised network (by listing their means of processing, resource, equipment and facilities incurred and cost involved for each programme), we may be able to make decisions about the suitable configurations to match the different functions in particular programmes since technologies applied are related to the structures of networks.

Suggestions about ideal configurtions can be made for each functions under different programmes (Table 6.1).

6.2.4 Establishment of Overall Performance Criteria and Measures

A network approach force detailed planning, organising, management policies and fiscal responsibility. The data generated to design and/or implement a resource sharing network will include the performance and specifications the systems must meet. Evaluation of alternative methods and network then becomes possible. The objective of having performance criteria and evaluation measures is to determine cost-effectiveness when making decisions concerning alternative methods to utilise resources for maintaining a high level of service to users.

In any modelling process, the objectives are expressed by the performance criteria and measures. Therefore, the identification and definition of performance criteria is usually thought as the first stage of modelling. In this project, some measures have been identified under consideration of three possible levels: effectiveness, cost-effectiveness, and cost-benefit.

Table 6.1: Suggestion for Ideal Configuration for each Functions under different Programmes

Function	Program One	Program Two	Program Three
OVERALL			
Governance	H[a]	H	D[b]
Communication	H	H/D	C/D
CA	H/C[c]	H	D
ILL	H	D	D
UC	C/H	C/H	D
IR	C	C/H	C/D

[a] Hierarchical
[b] Decentralised
[c] Centralised

A conceptual framework for performance measures (Figure 6.4) and two schema are worked out to indicate a general relationship among cost-effectiveness-benefits measures for the four basic network functions (Figure 6.5 & Figure 6.6). In the framework, all possible components of performance have been listed under effectiveness, cost-effectiveness and benefits (cost, time, and quality). In the schema, effectiveness measures serve to relate network performances (functions) to costs and to benefits. For example, in UC systems, system cost is partially determined by the volume of UC produced, by the staff time involved etc. System benefits are partially derived from such effectiveness as ease of use, coverage, timeliness, and number of entries etc.

However, technical processing of these functions, in most cases, can not be evaluated and measured directly in terms of user satisfaction. Technical processes must be designed and evaluated from two viewpoints: 1) internal efficiency and 2) external, long-term effects. Internal design and evaluation is concerned largely with time and cost factors. The external design and evaluation of technical processes involves longer term consideration: what is the long term impacts of technical processes? A framework is worked out to shown the possible performance measures to design and evaluate internal efficiency and external effects in each functions and the relationship of internal efficiency, intermediate external effects and long-term effects. (Figure 6.7)

Based on the effectiveness, cost-effectiveness and benefit measures that appeared in the above frameworks and schema, we can derive some more specific measure to be utilised in the mathematical models. Among them are those shown in Table 6.2.

The following definitions can be given:

Accessibility can be defined as the capability to communicate with the resource-sharing network by using a variety of ways; to enter, borrow, retrieve, consult all material necessary to the effective operation of a library and a network, necessary to the information need of users.

Figure 6.4: Framework for Cost, Effectiveness, Cost-effectiveness, Benefits for Overall Network & Four Functions

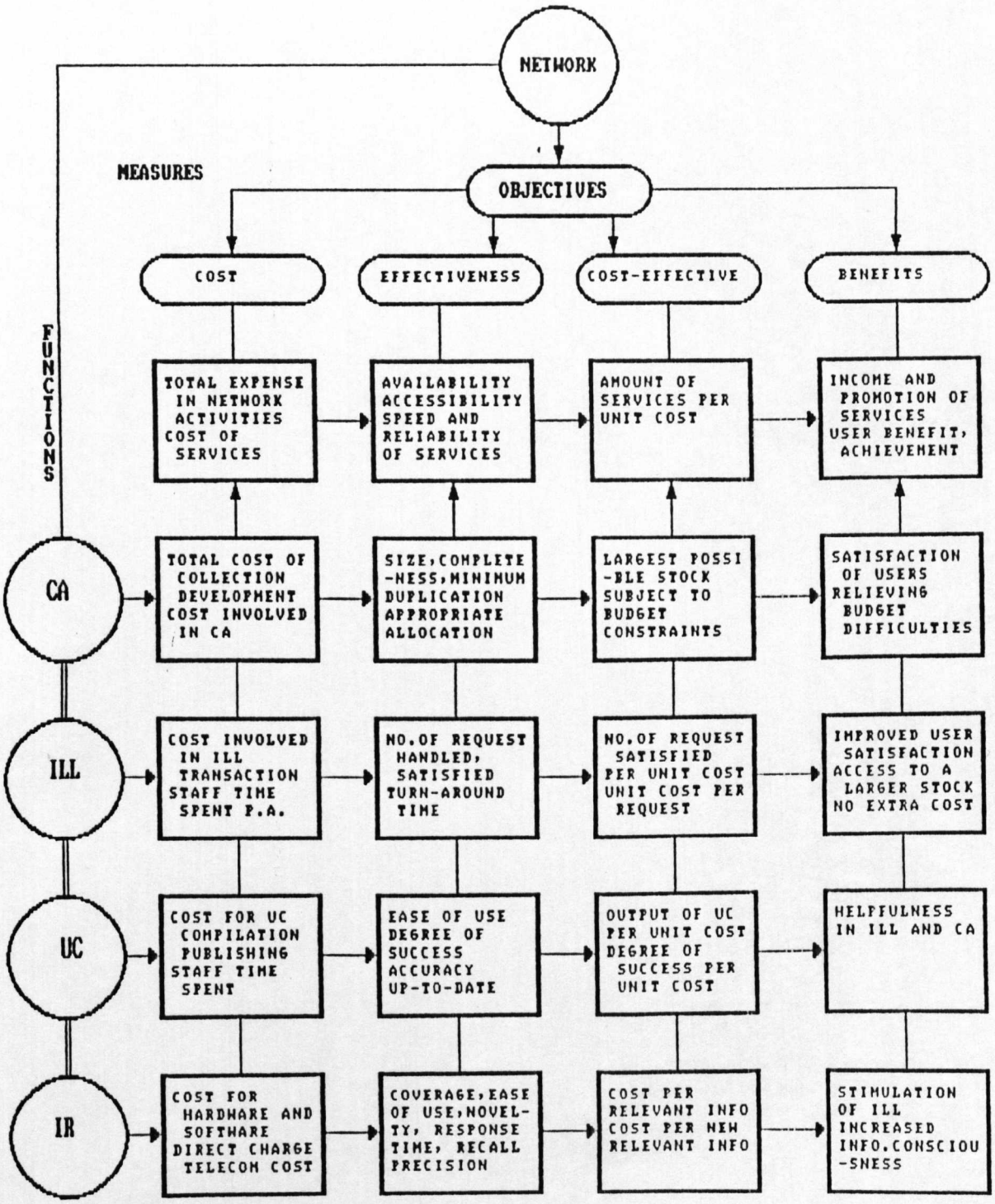


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Figure 6.5: Schema for Cost, Effectiveness & Benefits Measures for Four Functions

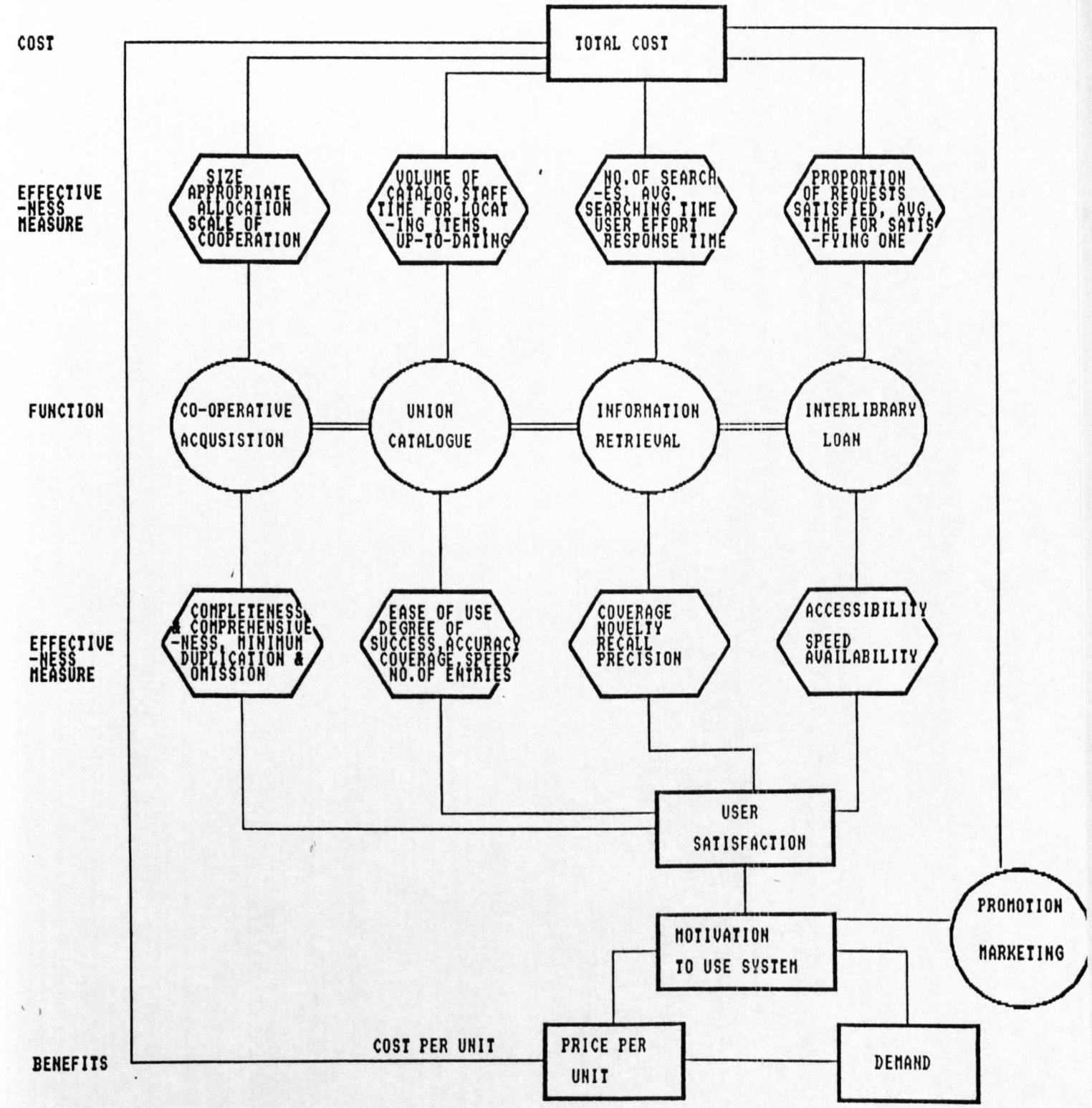


Figure 6.6: Schema for Cost & Benefits Measures for Four Functions

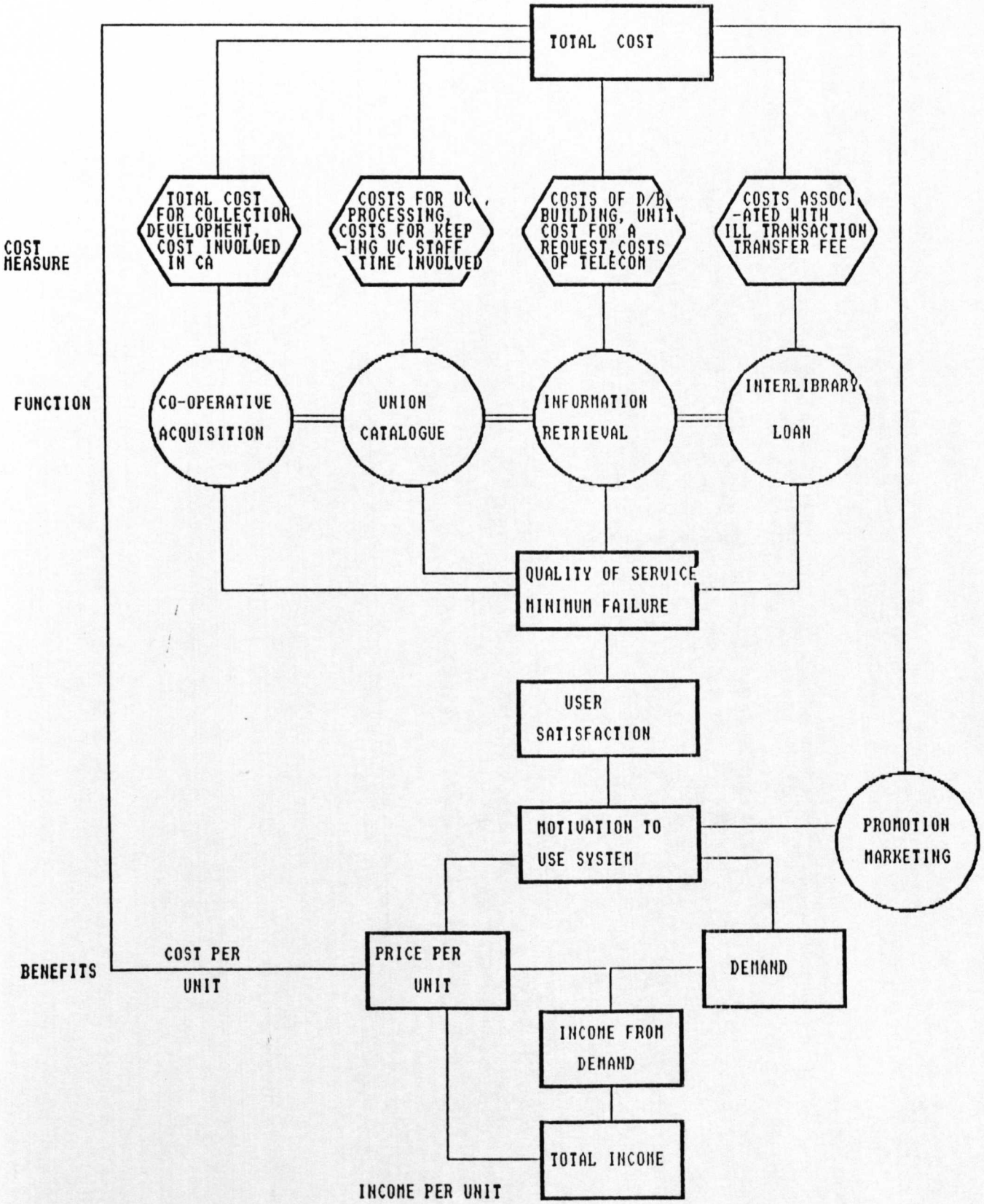


Figure 6.7: Internal Efficiency & External Effects of Technical Processing of Four Network Functions

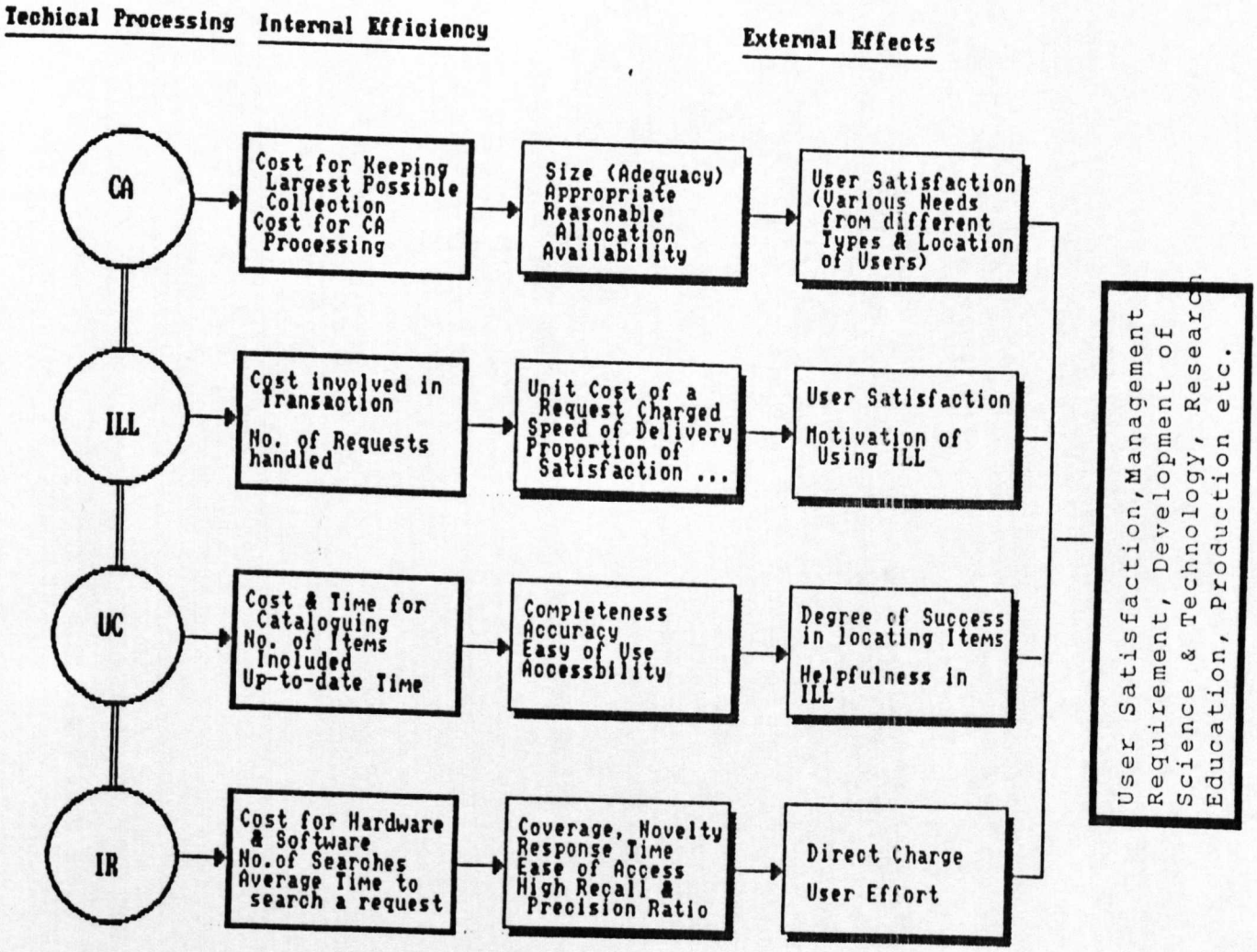


Table 6.2: Performance Criteria for the Network

Functions	
Overall	(1) Accessibility (2) Availability (3) Reliability (4) Speed (5) Cost-effectiveness
Co-operative Acquisition	(1) Material Accessibility (2) Cost-effectiveness of ILL outside (3) Geographical Accessibility (4) Local Accessibility
Interlibrary Loan	(1) Probability of Success (2) Turn-around Time (3) Costs
Union Catalogue	(1) Time-saving in ILL (2) Coverage & Accuracy (3) cost-effectiveness.
Information Retrieval	(1) Recall & Precision Ratio (2) Response Time (3) Costs

Availability is defined as the probability of gaining access to network at the desired time and the probability of success of services.

Timeliness (Speed) is defined as the speed at which a service can be offered.

Reliability, of a system, in technical sense can be expressed as the probability of it not failing.

Cost-effectiveness is concerned with a service's internal operating efficiency.

The definitions of the performance criteria under different functions will be given under the heading of the design of those individual functions.

6.2.5 Identification of three Programmes

Introduction

The establishment of objectives, and the selection of a suitable strategy have been recognised as the first two stages in the planning processes. Both should be undertaken only after a thorough diagnosis of the existing situation and in accordance with the constraints imposed by environmental factors and official policy. As we have been aware of, this is a time of rapid technological change. Some of this change will undoubtedly affect co- operation and

resource sharing and should therefore be taken into account in the design of the network. It must however, be borne in mind that, while the potential implications for the future may be large, there may be a considerable period before much effect is felt, and in the intervening period improvement is urgently necessary if network user demand is to be adequately met. Not only may developments be slower than has sometimes been predicted, but their economic implementation may prove difficult and will certainly take time.

If we have a look at China's situation, we notice that the application of computers and other modern technology in library and information services did not make significant progress until a decade ago, although attempts were initiated as early as 1956. There were technical and economic reasons for the slow development besides the political turmoil of the Cultural Revolution. One particular technical difficulty lies in the computer processing of Chinese Character, which made it impractical, if not impossible, to utilise the computers abroad that could readily process the Roman alphabet and Arabic numerals.

Encouragingly enough, many different systems have been developed in recent years. By 1985, the problems of both input and output of Chinese characters as well as internal processing had essentially been solved. The revolutionary progress will eventually bring out the computerisation in library and information world in China, as the Western intends to. Nevertheless, the present situation will not permit a widespread and high degree of computerisation in China in the near future due to certain technical, economic and political constraints. There are big gaps for the libraries and information services in China to fill in order to catch up with the development in the advanced countries. Moreover, a phenomenon existing in both developed and developing countries, is that there is a vast quantity of documents in the world's libraries in conventional form, to which conventional access is provided. Even if technology has a radical influence on the system of the future, the great body of knowledge enshrined in the past publications has still to be made available.

However, it is noticeable that new technology has brought out numerous impacts on the effectiveness of the library and information services. There are following possible changes caused by new technology:

I. Possible Changes in the Physical Form of Publication

These include

1. Publication in microform;
2. Publication in summary form, e.g. Synopsis Journal, with full text supplied on demand, whether in microform or hard copy;
3. High-density storage, such as holographs, bubble memories and crystals, whether reproduced in copies that libraries can acquire or accessible remotely from a centre;
4. The "electronic journal", in which papers are submitted referred and edited on-line, and are also available subsequently on-line; and

5. CD-ROM.

II. Changes, in Communication between Libraries (including locating, requesting and supplying documents)

The main technological developments relevant to communicating between libraries, to locating and/or requesting documents are

1. Facsimile transmission
2. Television technology — Viewdata
3. Other forms of document transmission (e.g. Satellite)
4. Computer technology (Line, 1980)

III. Changes in Information Retrieval and Storage

1. Mechanic
2. Computer technology
    - In-house database
    - Off-line
    - On-line

Whether the network will apply any of the aforementioned technologies, and which come the first priorities are critical issues in the design. Those questions have led to the birth of the idea to make cost-effectiveness- benefits comparisons of different programmes. Since the introduction of the computers enables the libraries and information networks to automate their process in the services, computerisation can be regarded as a revolutionary progress in information world. Thus, the programmes to be compared should be concerned with whether the computers will be involved in the network functions and how much they will be involved. In other words, how much computerisation the network will be is one of the major concern of the design.

Based on the above analysis, three alternative programmes are identified, and they are for networks

1. Non-computerised
2. Semi-computerised
3. Computerised

Definitions of three Programmes

The three alternative programmes, in general terms, can be defined as follows:

I. Program One—Non-computerised Network

By *non-computerised network*, the author means that all the processes of four major functions will be run manually, in other words, no computer will be involved in any processes of the four functions.

II. Program Two—Semi-computerised Network

By *Semi-computerised network*, the author means that parts of the processes of the four major functions will be carried out by the application of computers.

III. Program Three—Computerised Network

By *Computerised Network*, the author means that all the processes or majority of the processes of four major functions will be computerised as much as possible.

Identification of the Components in three Alternative Programmes

Attempt should be made to elaborate on the technological and economic issues involved in the programmes. And the consideration of possible future system based on the possible technology of the future should be taken. However, the difficulty should be anticipated since there are too many unknown factors in the situation, and the possible permutations of technological advances on various fronts are too numerous.

To make a preliminary cost-effective-benefit comparison of non-computerised and computerised network functions, it is important to identify the components of the three programmes The author has made attempts to identify 1) the means of processing of four functions under different programmes (Table 6.3), and 2) the possible resources, equipment and facilities, which will have to be incurred to make those different programmes work (Table 6.4); 3) the comparative weights of effectiveness measures between the programmes (will be presented in Chapter Ten); 4) the ideal configurations possible for each functions under different programmes (see Table 6.1.).

The choices of means and resources for non-computerised and computerised programmes are straightforward while that for semi-computerised programmes is based on the knowledge of technological advancement, Chinese circumstances and the author's personal preferences.

Specific definitions of the three alternative programmes need to be made for the individual functions. They will be discussed in the respective chapters.

Table 6.3: Comparison Among Three Programmes (Means of Processing)

(Means of Processing)

Fuctions / Processing	Program One (Non-Computerised)	Program Two (Semi-Computerised)	Program Three (Computerised)
CA			
Interlibrary Communication	Mail/Meetings	Mail/Meetings	Electronic Mail /Teleconference
Collection Evaluation	Manual(Data-Collection)	Manual(Data-Collection)	Manual/Computer (Data-Collection)
Collection Analysis	Manual	Manual/Computer	Computer Anaylysis
Policy & Plan -making	Meetings	Meestings	Teleconference
ILL			
Verification	Manual	Manual/In-house Database	In-house Database/ On-line Catalogue
Transmission	Mail/telephone	Mail/Phone/Telex	Electronic Mail
Document Supply	Mail	Mail	Mail
Reproduction	Photocopy-Mail	Photocopy-Mail	Photocopy-Mail Full-text-Computer
UC			
Cataloguing	Manual-Cards	Manual-Microfiche	MARC-Inputing
Compilation	Manual	Manual/Computer	Automatic
Production	Card/Print	Microfiche/COM	On-line MARC/COM
IR			
Database Building	Secondary Sources Acquiring	Databases Subscrip -tion/In-house	Databases Subscrip -tion/In-house
Searching	Manual-Print form	Off-line Searching in centre	Searching via Network Centre & National Centre
Reproduction	Photocopy	Off-line Print & Photocopy	On-line Print/ Dowloading

Table 6.4: Comparison among Three Programmes (Euipment & Facilities)

(Resource, Equipment & Facility incurred)

	Program One (Non-computerised)	Program Two (Semi-computerised)	Program Three (Computerised)
Co-operative Acquisition	Staff Time	Staff Time	Staff Time Computer Software Package
Interlibrary Loan	Staff Time Telephone Photocopier	Staff Time Telefacsmile Machine Photocopier	Staff Time Telephone (dedicated) Computer (Terminal) Photocopier
Union Catalogue	Staff Time Cards Print facility	Staff Time Microfilming Camera Films & Readers	Staff Time Computer, Tapes & Discs Software Package
Information Retrieval	Staff Time Printed Secondary Sources	Staff Time Computer in Centre Database Subscrip -tion In-house database Searching Software	Staff Time Acoustic Coupler Computer Terminals Telephone(Dedicated) In-house Database Searching Software

6.2.6 Determination of Network Governance, Policies and Standards

As discussed in Chapter One, [illegible] in a broader sense, the purpose of governance is to provide a mechanism for overcoming the barriers to any "new" organisation such as a library network. The principal difference among the categories (discussed in Chapter One) involve the organisational environment and its relationships with member libraries as expressed by policies; and in the incentive for co-operation.

Based on the analysis of China's situation, i.e. centralised social system, the suitable governance structure for networks falls into the first category, i.e. governance by government.

The governance body should supervise the formulation of network policies and facilitate the standardisation in the network.

6.2.7 Determination of Network Functions

There are arrays of network functions performed by the existing networks and network in design. Based on the knowledge of those conventional functions and the Chinese situation, the author decides to choose the following functions for the network being designed:

1. Co-operative acquisition (CA)
2. Interlibrary loan (ILL)
3. Union catalogue (UC)
4. Information retrieval (IR)
5. Compilation of bibliographic tools and references
6. Training programmes etc.

of which, the first four are to be designed in detail.

The importance of those four functions can be seen through the following discussion.

Co-operative Acquisition (CA)

The broad term "Co-operative Acquisition" refers to joint action in acquisition and utilisation of information resources. Beginning with the preliminary stages of selection, organisations come together in a network for actual purchase of materials, resulting in joint ownership and/or use (PEPS-UNESCO, 1985). It is believed by Williams and Flynn (1978) that the function of CA is critical to any successful library network since the primary goal of a library is to provide users with access to information at the lowest possible costs. All library activities

such as acquisition, cataloguing, processing, reference, circulation, etc., are performed with this in mind, it is difficult to imagine that a unified acquisitions function within a network cannot perform more cost-effectively.

"Co-operative Acquisition" is used to cover all types of acquisition programmes whether joint ownership, centralised purchasing, specialised areas of acquisition etc.

Interlibrary Loan (ILL)

But CA cannot be effectively implemented without an effective ILL system because the fear of not being able to borrow what is not bought will destroy its intent. Therefore, ILL is also one of the most frequently and enthusiastically cited network benefits as it provides mechanism for efficient document delivery as a lower cost than actually purchasing the said document.

This activity is specially useful in the case of rare and important books or books in limited circulation. Mechanisms for the safe/speedy delivery of documents to and from network members are vital.

Union Catalogue and Union Lists (UC)

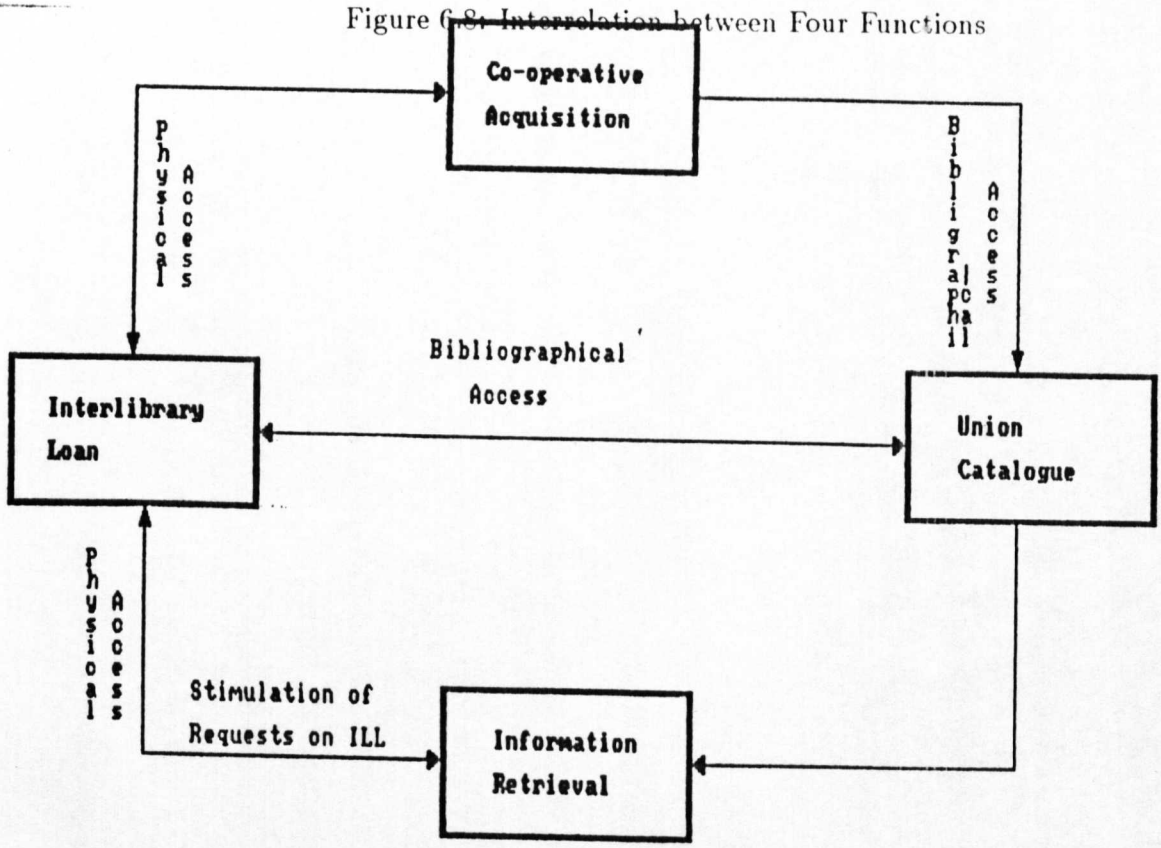
If libraries are to effectively share resources, it is vital that they are able to ascertain each other's holdings. The answer to this need is the creation of UCs or the distribution of catalogues of individual libraries.

Listing in a UC is an essential network feature, requiring each member to take responsibility for forwarding cataloguing information to national or regional focal point on new material received. In essence, network members offer information about their respective holdings or are requested by focal point to identify their holdings, their location and availability. This activity is particularly important among "extended libraries" engaged in many ILL activities.

Information Retrieval (IR)

Information Retrieval is an area that can benefit greatly from co-operative efforts. The resources used in the IR function (Reference, Databases and so on) are among the most costly to acquire. The technology, especially, if computer-based, can usually be purchased more economically by the network than by the individual member libraries. Furthermore, the software and hardware to support these communications activities can be more readily maintained through the network than through the member libraries (Williams & Flynn, 1978)

Figure 6.8: Interrelation between Four Functions



Relationship of Functions

It is of importance to understand the relationships of those functions in the design. The functional relationship can be illustrated in Figure 6.8.

The functions to be performed by a network determine its physical structure as well as its logical organisation. The interaction among functions needs to be understood in order to design cost-effective networks and to be able to make valid judgements regarding their performance. It is believed by Williams and Flynn (1978) that designing networks to fit a specific set of functions is preferable to designing functions to fit a specific network. A network designed to perform a specific function such as cataloguing is not necessarily well suited to perform the circulation and vice versa. If the relationship between these functions is not known and utilised in the design of a network to perform both functions, it is unlikely that the network will be cost-effective in its operations. Therefore, it seems appropriate that the network functions be understood in terms of their individual requirements and their impact on their functions. The impact of a function performed by a network upon other functions performed within member libraries, or by another network utilised by the member libraries, is also important to the design and evaluation of library networks.

Keeping in mind that library functions do not exist in isolation but are related to each other, it is important for any attempt at networking to consider not only the individual function the libraries decide to perform, but also the relationship among each of the other functions

libraries perform. It may be that the benefits derived by performing one function through the individual libraries, thus completely offsetting the networking benefit. For example, a network policy of resource sharing and CA will result in increased ILL activities. If these activities are not also network-supported at an efficient level, the individual library may find that the costs increased in filling ILL requests more than offset the benefits derived from CA. This would lead one to infer that a network must look at the cost benefits across all functions rather than a single function in order to make reasonable network design and utilisation decisions.

6.3 A Library & Information Network to be Designed—ZALINET

6.3.1 Introduction

The embodiment of the overall design can be based on the the consideration, identification and determination of the above design issues combined by the identification of environmental factors and the review and evaluation of the present situation of China's Library and Information Systems in Chapter Five. As a summary of the determination, a brief description of the network can be made for ZALINET, which stands for Zhejiang Agricultural Library and Information Network. A brief introduction to Zhejiang province is given in Appendix A.

6.3.2 Description of the Network designed

1. *Geographical Scale*: provincial (including provincial, prefectural and county level—28 main nodes).
2. *Types of Nodes*: libraries and information centres in the sectors of agricultural education, research, production and governmental administration etc.
3. *Governance*: by Governmental body.
4. *Co-ordinating Body*: composed of four major libraries and information centres (ZAAS, ZAD, ZAU and CNRRI).
5. *Objectives*

   A. High-level:

   a. To relieve budget difficulties for purchase of collection in the individual libraries and information centres in Zhejiang;

   b. To improve the effectiveness of those libraries and information centres;

   c. To provide comprehensive, timely and cost-effective services to satisfy the various information needs of the different types of users in different geographical locations within Zhejiang province;

   d. To provide effective information services that promote agricultural decision-making, research achievements, production level, education quality and marketing.

c. To ensure that the information network fits into the overall plans of the central and local governments.

B. Low-level:

a. To provide information services with reasonable accessibility and availability of information needed;

b. To provide an ILL service with high fill rate, low time delay and cost;

c. To establish location information for effective ILL services;

d. To provide effective IR services with highly relevant information, at low response time and costs.

6. *Types and Function of the Network*:

A general model of a provincial agricultural library and information network in China would be characterised symbolically as iii., 1, 2, 3, 6, 7, A, B. (vide Chapter One)

The determination of the configuration for the network are based on the thorough diagnosis of the existing administrative structure. The existing structure, being a non-rigid hierarchical configuration, has complicated the management and information flow. The configuration of the network, in terms of management, should be a composite star. The configuration for each function will be determined in the chapters of design those functions.

More specifically, the network will be designed to carry out the following functions:

a. Co-operativeacquisition

b. Interlibrary loan

c. Union catalogue

d. Information retrieval

c. Others

7. *User Groups*: Administrators, decision-makers, research workers, lecturers, students, technician and farmers etc in the field of agriculture.

Chapter 7

Design of Co-operative Acquisition Programme

7.1 General Considerations

7.1.1 Introduction

If we trace the history of co-operative acquisition in USA and other advanced countries, we find that the first major effort in co-operative collection development came in the post-war period with the formulation of the Farmington Plan in 1947. A true CA project, the Plan's goal was to ensure that at least one copy of foreign publications would be owned by an American library. The plan was noble in scope, but eventually failed owing to changes in participating institutions' programmes, the unreliability of some foreign booksellers, budget restrictions, and shifting trade balances with their concomitant effect upon currencies. In 1960s, the Centre for Research Libraries in USA became a large scale national resource sharing system. Although the centre today is undergoing a reappraisal of its objectives, its mission has been the centralised storage of lesser-used materials, the acquisition of expensive material not in general acquired by members, and a prioritised delivery system. When machine-readable cataloguing became available, bibliographical utilities and network consortia proliferated in the 1970s, led by giants such as RLG and OCLC. The most recent project on a national level is ARL's national Collection Inventory Project, which is utilising RLG's collection statements as a basis for assessing collection levels of member institutions. (Rustein, 1985)

A similar project in Germany preceded the Farmington Plan. The Prussian State Library and the ten university libraries in Prussia formed a closed system, with their librarians responsible to the Ministry of Education in Berlin rather than to their own institutions. They became "models for well-planned library co-operation", and among the lasting effects of this system are the pattern of interlibrary loans and the assigning of special fields of collection development to different libraries.

The earliest regional specialisation scheme in Britain began in 1948, with the Metropolitan Special Collections Scheme. The scheme had its beginnings in discussions between the Chief Librarian of the twenty-eight Metropolitan Borough Libraries upon probable future library developments after the war and possible ways to improve book and periodical provision collectively to the degree attained by "library services of great provincial cities", without losing the individual character of participating libraries. The Metropolitan scheme aroused interest in other regions. There followed several similar schemes. Then, the inter-regional coverage scheme was introduced in 1959 to initiate the idea of self-sufficiency in current British book, on a national scale. However, with the establishment of The British Library it was decided to end the Inter-regional Coverage Scheme, on 31st December 1973. The formation of The British Library Lending Division, from the amalgamation of the NLL and the NCL, its acquisition policy and its speed of service supported their decision: "significant" works would be available from the BLLD and "lower level" items which the BLLD might fail to purchase would be available through the "back-up" services of the copyright libraries. Regions, however, would still remain responsible for those books collected under the scheme between 1959 and 1973. (Jefferson, 1977)

How was and how is the situation in China? Some scale of the regional and professional Co-ordination Programme for Book Purchase can be traced back to the later 1950s. As mentioned in Chapter Five, in 1957, a "Book Group" was set up to assume the role of co-ordinating and project making. Led by the State Scientific and Technological Commission, the "Book Group" was formed by the representatives of the Ministry of Culture, the Ministry of Higher Education, the Academia Sinica, the Ministry of Public Health, the Ministry of Geology, the National Library of Peking (renamed National Library of China in 1981), as well as some experts in library science. Chapter five has reviewed the establishment of the 11 Central Libraries Committees in late 50s and their roles in co-operative collection development. After the Cultural Revolution terminated, more and more co-ordinated programmes for book and periodical acquisition, especially for foreign periodicals have emerged at regional or professional levels.

The immediate and most powerful impetus to alter the idea of local self-sufficiency may be the severe recession and inflation. With competing pressures for money, libraries are often categorised as a non-essential resource, and witness their budget reduced. Adding to the dilemma, the so-called "Information Explosion" has not abated, and user demand for information only seems to increase. At the other end of the spectrum, it is becoming evident at the same time that the great storehouses of collections are decaying at an alarming rate.

Since libraries concluded that they could no longer meet the demands of their users through normal collection channels, they began to see access to information rather than possession of information itself as a likely way to meet these demands.

CA, to some extent, encourages a strong emphasis on decentralisation, and at the same time diversity enhances the value of co-operation. Moreover, each affiliate in a network consortium would retain control over book selection and develop collections appropriate for its users. Other, more direct benefits include the following: 1) fewer little-used titles are necessary because of their availability from other sources, 2) cost-effectiveness is encouraged, 3) co-ordinated preservation policies are enhanced, 4) unwanted duplication is avoided, 5)

communication between network members is enhanced, and 6) areas of strength are identified.

However, it has been said that resource sharing programmes have seldom achieved the power in practice that is attributed to them in theory. And logically the first stage of resource-sharing should lie in the accession function. It is here, however, that the will to co-operate is most difficult to translate into reality. Individual libraries owe prime responsibility to their users, and select material either in response to expressed demand or in anticipation of demand based on a knowledge of their users and their professional skill. Any acquisition of material above this can only be valid if it will lead to benefits for library users. If we take a close look at the problems faced in CA, it seems that user habits, local autonomy and institutional difference arise as major obstacles to co-operation.

User Habit

Studies have shown that scholars and researchers utilise informal means of communication in accessing information. Important among these are conferences in their disciplines, selected professional journals, and exchanges with colleagues. They usually have little time for complete literature searches and retrieval of the necessary documents. They are averse to spend much time obtaining the information which is not readily available. This is one reason that interlibrary loans account for only an insignificant proportion of a local library's total circulation, which further discourage the movement of CA (Ballard, 1982). This situation is applicable to agriculturalists in China.

Local Autonomy

Within a resource-sharing environment, freedom of movement among network members is limited. Libraries usually are servants of their parent organisations, and their fortunes must reflect the institutional mission. Belonging to a network does not guarantee commitment to collect in subject areas. Co-operation may even encourage budget-cutters. Moreover, policy-making can be another obstacle. Planning is normally centralised in a network, but librarians at member institutions will be making decisions in a decentralised environment, often without regard to the objectives of the network. Also, some libraries have no internal structure for collection development, and so are unable to participate equally with their partners.

Institutional Difference

Another primary reason why co-operative collection development in multitype library networks is difficult to achieve is the gap in contributions. CA succeed only as long as each participant perceives them as beneficial to the institution. It usually is the larger libraries that are responsible for a larger bulk of the transactions. In this sense, the large library contributes heavily and receives little gain, which again discourages the participations of large libraries.

Other impediments include the following:

1. There is bound to be conflict between the responsibilities of a library to its own users and those which undertakes as a member of network in economical aspect;

2. A library must face another conflict between the needs of its own users and the other members of the network;
3. Access to information may in the long run be as costly as local purchases;
4. Filling gaps will be expensive if sharing agreements are terminated;
5. Libraries joining networks in period of retrenchment may be less willing to participate in rosier times; and
6. If co-operative collection development is not properly promoted, administrators and users may find unacceptable the use of acquisitions budgets for resource sharing and other networking agreements.

7.1.2 Definitions and Concepts

Co-operative Acquisition

The broad term "co-operative acquisition" refers to joint action in acquiring and utilising information resources. Beginning with the preliminary stage of selection, organisations come together in a network for actual purchase of materials, resulting in joint ownership and/or use. (Atherton, 1977, p112)

The following terminologies have been frequently used to discuss the concepts of co-operative collection development:

1. Information Resource Allocation (Distribution)
2. Co-operative (Co-ordinated) Collection Development
3. Co-operative Acquisition

To some extent, they can be regarded as synonymous.

Information Resource Allocation (Distribution)

Information Resource Allocation (Distribution) here refers to the optimum geographical placement and allocation of information resources. It usually includes two levels: first, the spatially natural distribution of information resources; and secondly, the optimum re-distribution upon the natural distribution by human effort. A national or regional information resource allocation is referred to the programmes in which information resource at dispersed, disorderly and motley manner will be reorganised and redistributed in a planning way so that a unified national (or regional) information resources system can be established as a back-up to satisfy the information need from the whole society. This term is usually used to describe the co-operative programmes emphasised on geographical areas.

Co-operative (Co-ordinated) Collection Development

Co-operative collection development may be defined as the process by which a group of libraries develop individual and/or joint collection within an overall plan for accomplishment of certain goals. (Fiels, 1985, p2)

CA is one of the goals of Co-operative Collection Development. In this thesis, CA is used for the most of the cases.

7.1.3 Design Issues of CA System

Before any CA Programme is determined, it is important to find the answers to the following questions:

- What resources currently exist in the libraries of the network and where are they?—(Collection Assessment)
- In what areas are the libraries of the network repeatedly unable to fill requests for information?—(Usage Studies)
- Who will collect expensive and less-used material?
- How does and will ILL related to CA?
- What are appropriate levels of responsibility for local libraries, systems and networks?—(Policy-Making)
- How does the network deal with getting enough popular material for everybody?
- What is the impact of CA on individual institution's budgets?

Those questions force the designer to identify the essential design issues and principles, and seek the solutions of the problem areas. The following headings are aimed at these directions.

Key Elements of CA

The key elements of CA identified by Fiels (1985) (except the last one) are adopted and some interpretation and insights of the author are added:

Firm Commitment (Responsibility)

It is one of the most important elements to resource sharing. When a library agrees to change its collection policies in order to adapt it to network overall policies, it must be absolutely confident that it can depend on long-term access to other collections it now relies on. It is essential to work out a formal agreements with legal responsibilities through the meeting of participating member libraries. It should show a firm and long-term commitment in the agreements.

Interlibrary Communication

To carry out a CA programme, communication of three types is essential:

1. Libraries must be able to communicate management information on an ongoing basis to ensure continued co-operation. Frequent meeting, saying quarterly or annually, should be called on to report library management information about library acquisitions and circulations so that some degree of modification can be made during the implementation of the plan.
2. Libraries must be able quickly to locate bibliographic holdings and status information on materials in other collections. This suggests that union catalogue of some types be compiled and produced to help access the collections acquired co-operatively. The details of the UC programme will be discussed under the design of UC systems;
3. Libraries must be able to quickly and easily place ILL requests for those items once they are located. This suggests that a mechanism of request transmission be set up to allow fast transmission.

Physical Access to Material

While electronic communication systems speed up the location and requesting of materials enormously, many studies indicate that the actual time requested to get materials into user hands has in fact changed very little. As a result, delivery speed is critical issue in any network. In the design of total system, both moving material around—document delivery and moving people around—direct access by users to other libraries must be taken into account.

Shared Methodology for describing, evaluating and analysing Collections

It is necessary to have a standardised methodology for describing, evaluating, and analysing the collections of each library. Firstly, a project needs to be carried out to devise a standard and comprehensive listing based on the national classification scheme, in which a number of descriptors should be identified.

Secondly, an evaluation of collections seems necessary. The purpose of evaluation is to present an indicator of collection strength and weakness. In general, all evaluation techniques to date may be described as either collection- or user-centred. In collection-centred techniques, a collection is treated as a resource irrespective of actual demand and use. It focuses on the intellectual breadth and depth of the collection and responds to the concept that a research collection's value is intrinsically related to the unknown needs of future scholars. User-centred techniques focus on the actual utility of the collection to its current users. Collection-centred techniques depend on such factors as size of collection, age of collection, conformity with standard bibliographies, or the judgement of subject experts. While user-centred techniques derives quantitative information on collections through usage studies. These include circulation studies, document delivery tests, shelf availability studies, in house use studies, and citation studies. However, both collection- and user-centred techniques present advantages and disadvantages, each serves to suggest more clearly strength of collection in meeting local

and network need. Some sort of the combination seems a more reasonable mechanism to adopt.

Thirdly, analysis will normally follow description and evaluation. Analysis will be undertaken to identify and assign the collecting levels and areas for primary collection responsibility. The assignment should be accepted and agreed by member libraries. Therefore, they have the obligations to maintain the prescribed level of collecting in the designated subject area, and thus guarantee that the network resources will proceed in a logical and orderly manner.

It is expected that once the descriptions and assignments are complete, cost savings will result either from title specific purchase avoidance, or more important, from reduction in the collecting efforts of some members where redundancy is apparent, without sacrificing local autonomy.

It is, however, controversial whether CA programme is really cost-saving.

Accurate Statistical Information

It is important to collect some accurate statistical information on collection usage and ILL activity, which can be used to determine the fill rate on a subject/collection basis, and to provide an "objective" measure of collection strengths and overlaps between collections. Ideally, decisions about CA should be made on the basis of hard numbers, rather than conjecture or assumptions about usage not based on firm data. Until a clear picture of current use of materials is available, sound decisions cannot be made, nor can the impact of any CA program be evaluated. But all too often, CA plans are set up according to an intellectual model without a clear understanding of actual use.

Firm Plan

To promote the CA programme, it is necessary to work out a formal, written plan. This plan requires a definition of the population to be served; a statement of needs, goals, objectives, activities and responsibilities of each library in the overall scheme.

Exchange and Re-distribution of Material

As we all know, the ultimate aim of CA is to deepen and broaden the total resource available at the least cost, and implicit in co-operative acquisition and storage is the principle of exchange and distribution of materials. In the case of subject specialisation, the rationalisation and preservation of material to form comprehensive collections and at the same time avoid the disposal of the last copy, requires integration by the exchange of material. The materials to be exchanged fall into two main categories: 1) internal publications (not for sale, or difficult to trace and buy); 2) out-of-print works to be discarded by other libraries. It is necessary to work out a network exchange schemes, by which, the material offered depends on the selection and discarding policies in individual libraries.

Methods of CA

Two major types of methods can be adopted in CA activities. The first by subject specialisation and the second by a more empirical method whereby participating libraries review books that have not been purchased within the group or come to some agreement on expensive items of small demand for common use.

Subject specialisation as a method of CA is preferred as having the advantages of simplicity in allocation, and if libraries honour their specialisation obligations, an assurance that within the co-operating area subjects will be self-locating. From this follows the possibility of speeder ILL and directing users to specialised collections, as well as a greater degree of regional self-sufficiency.

Objections to the arbitrary allocation of subject fields, and the fact that libraries often have to accession books of no possible interest to them, have caused some network to adopt a more pragmatic basis for their scheme of CA. This usually takes the form of frequently consideration by network Executive Committee of more important items that have not been purchased by any of the libraries in the region or area, and their supply by mutual agreement. A combination of both methods would be a reasonable to apply.

Based on the above identification and discussion of design issues and principles, the author, therefore, is able to construct both descriptive and mathematical models for CA in Chinese circumstances. The following two sections are devoted to meeting this end.

7.2 Optimum Information Resource Allocation—Descriptive Models

7.2.1 Overview

Information resource allocation (distribution) nation-wide, region-wide or system-wide can be divided into two types, i.e., macro-level allocation and micro-level allocation. The former refers to the reasonable and scientific plan and arrangement for information resources within the scale concerned, while the latter refers to the optimum information resource allocation within one library or information centre to satisfy users' needs to a maximum degree. (Wu, 1985)

Agricultural Information Resource (AIR) Allocation(distribution) in China are affected by several factors, such as, vast land, big population (especial agricultural population), complication in agricultural production conditions, and distinctions between geographical areas etc.

As mentioned in Chapter Five, the unfavourable conditions have impaired the development of information resource. And China is now faced with three severe crises: 1) low total coverage of information resources; 2) parallel duplication and serious budget waste; 3) imbalance in

the distribution of information resources among geographical areas. Therefore, the objective of a national information resources allocation programme should be [illegible] to solve these problems.

7.2.2 Optimum Distribution of AIR nation-wide

Geographical Characteristics of Agricultural Production

As we all know, the entities of agricultural production are concerned with living things (animal and plants) whose growth, development and reproduction rely very much on certain natural environments. China has a vast land, which covers eight temperature zones. From south to north it ranges from equator to frigid temperate zone, while from east to west, it varies from rainy and wet areas to dry and desert areas. The geographical conditions of the country include mountain, plateau, hill and plain. Therefore, agricultural production shows rather distinct geographical/regional differences. In order to monitor the national agricultural production at macro-level, the whole country has been divided into several agricultural areas according to geographical areas There are three levels in such a division of agricultural areas. The first level is the division for nation-wide, and the second and the third levels are the divisions for province-wide and county-wide respectively. For example the first level areas consist of the following regions:

1. The North-eastern
2. Inner Mongolia and the areas along the Great Wall
3. Huang Huai
4. Loess Plateau
5. Yangtse River
6. The South-western
7. Southern China
8. Gan-Xin
9. Qin-Zhang
10. Oceanic Fishery

It it noteworthy that this division differs from the division for six administrative regions in some aspects but overlaps to a great extent.

Distribution of AIR

Because of the distinct geographical characteristics in agricultural production, information resources, therefore, should be distributed by the consideration of the balance between geographical locations. The following principles are proposed:

1. Treating a region (or area) as a unit;
2. Co-ordinating among different professional systems; and
3. Managing in a centralised mode within the regions but a hierarchical mode nation-wide, etc.

Such principles are expected to promote the development of regional (provincial) distribution of AIR by suiting measures to local conditions. The idea of treating the area as a unit, is mainly based on the following:

1. The geographical characteristics of agricultural production, research, education and marketing etc.;
2. The distribution pattern of agricultural production forces.

For instance, the locations of the different agricultural research institutes show the distinct geographical characteristics: six research institutes of three subjects—Animal Husbandry, Veterinary and Prairie, affiliated with Chinese Academy of Agricultural Science, are located in Gan-Xin, Inner-Mongolia and Areas along the Great Wall, and North-eastern Regions, which are the base of Animal Husbandry. And national research institutes of Rice, Silk-worm and Tea Science, affiliated to the Chinese Academy of Agricultural Science, are situated in Yangtse River area, which is the major production area of rice, silk-worm and tea. The characteristics and subject biases of agricultural universities, especially the Key Universities in China also reflect the agricultural production of the locality. The universities scattered in Eastern, Southern, Western Northern and Central China form a national agricultural education network.

On the regional or provincial scale, the existing pattern of agricultural resources already has laid a reasonably solid basis. Furthermore, the formation of an integrated management system for agricultural libraries and information services is also under way. It is practical and reasonable if we put the emphasis on the geographical characteristics in the distribution of agricultural information resources, and develop agricultural information systems based mainly on regions (areas). (Zhang, 1990)

Nevertheless, one serious problem faced is that agricultural libraries and information services at different levels are affiliated to different parent organisations. In addition, there are various ways of integrating one another. Thus there forms complicated systems. The lack of communication and co-ordination, within and between systems, have caused a severe situation,

in which the overall efficiency of information provision is low; the potential of information resources has not been fully tapped; and the problem of duplication and waste are rather serious.

Network for AIR Distribution

AIR scientifically-well-distributed along geographical regions does not necessarily imply a uniform distribution among the areas. To allocate AIR reasonably, historical and present conditions, developmental trends, in terms of economy, culture, education and science, and the existing resource situation of libraries and information services must all be taken into account and planned accordingly. Thus, a network for the distribution of the agricultural information resource with largest possible coverage can be expected.

The following infrastructure of agricultural information resource centres can be recommended:

The First Level: National Resource Centre

Beijing will be the location for the national centre, in which AIR, of all forms, in all sub-fields of agriculture, and all languages, and those relevant to agriculture should be collected.

The Second Level: Regional Centres

The candidates of the centres will be the libraries and information centres situated in the big and medium size cities in seven administrative regions. Those centres are responsible for collecting some relatively high-level information and some expensive, or less-used documents in accordance with the real situation of production, research and education in the regions so in this way the second can release the first level from the high pressure of information needs placed upon it.

The Third Level: Provincial (Municipal and Autonomous Regional) Centres

The centres will be the libraries and information services situated in the capital cities of the provinces (Municipalities, and autonomous regions). They will aim at collecting the important information resources to satisfy the need of research, education and production in province-wide (municipality-wide, autonomous region-wide).

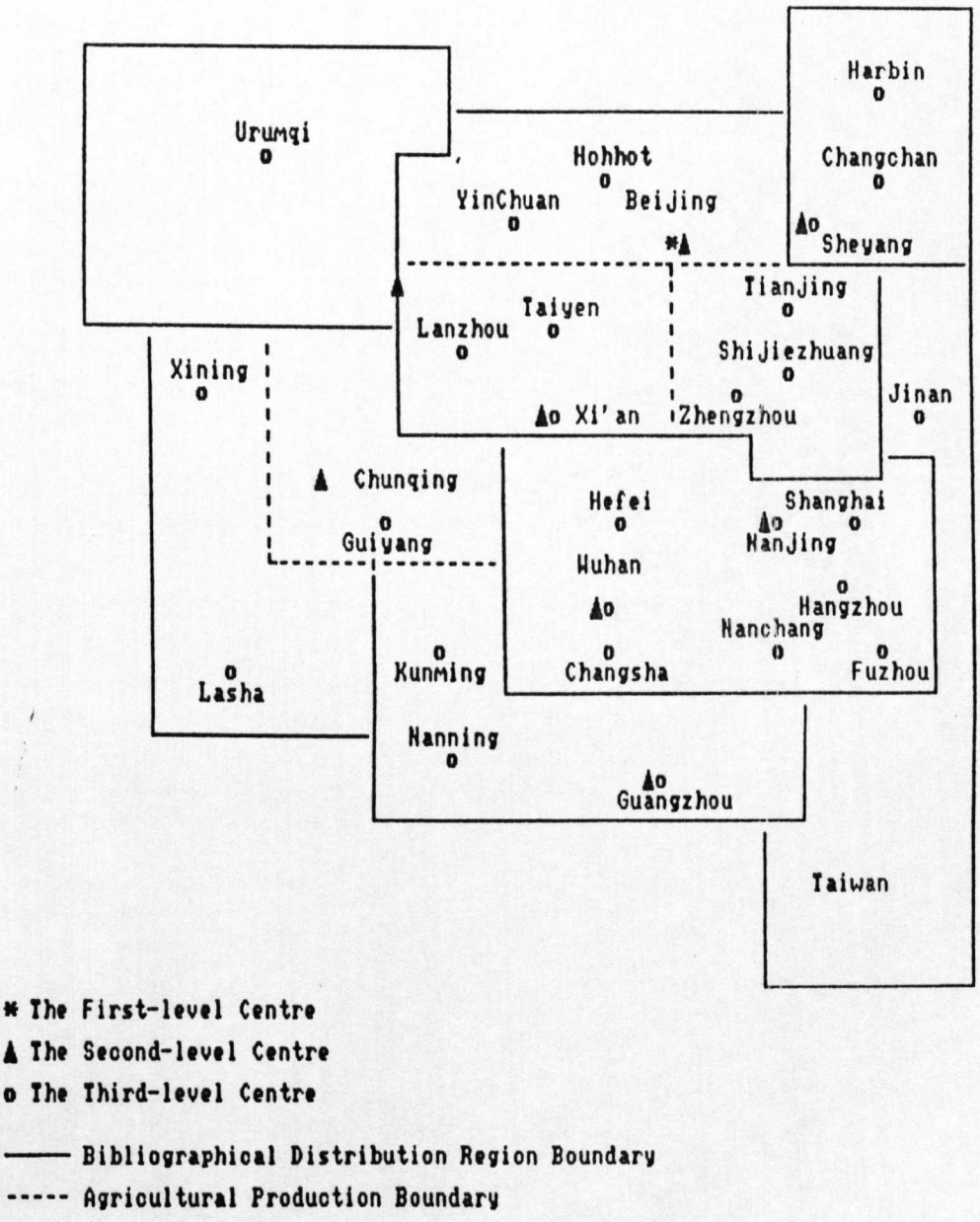
The Fourth Level: City (County, Town) Centres

The centres are the ultimate fronts to provide the necessary information about the technological extension in agricultural production. The main user group will be the large numbers of farmers, specialised household farms and township enterprises.

The locations of the upper three level centres can be illustrated in the map (Figure 7.1).

The system can be configured as hierarchical in terms of organisation and management of CA programme. But the processing of acquisition will take different configurations. It depends very much on the technologies applied, which will be discussed later.

Figure 7.1: Geographical Locations of the Centres at Three Levels



To sum up, National AIR Allocation requires that the allocation should

1. Be suited to the development of science, education, culture and economy in China;
2. Be suited to the intellectual level, information need, and absorbing ability of researchers, educators and administrators in different areas and different systems;
3. Be suited to the industrial and agricultural production in different areas and make full use of the intellectual tradition and cultural development in different areas;
4. Have certain levels so that the sum of the information resources at different levels can be utilised to satisfy information need at respective levels, which promotes the dependence and integration among libraries and facilitates the formation of resource-sharing network; and
5. Facilitate the application of modern technology so that the establishment of computerised bibliographical databases can be speeded up.

7.2.3 Optimum Distribution of AIR province-wide, with particular reference to Zhejiang Province

Similarly, province-wide, it has also shown clearly the distinguished geographical characteristics in agricultural production, research and education emphasis among the prefectures. Therefore, from an overall point of view, AIR should be allocated to support the emphasis and to satisfy various information needs from different locations.

To reflect the characteristics, proposals concerning political issues and strategic allocations for Zhejiang provincial AIR Distribution can be made:

I. Political Issues

AIR allocation province-wide should be

1. Led by the national policies about the Economic Reform and Reforms in Science and Technology System, and Education Systems;
2. Based on resource-sharing among University, Public, and Research Library and Information systems;
3. Co-ordinated and instructed by an unified executive body.

II. Strategic Allocations

In the case of Zhejiang province, the first step is to allocate AIR to the seven cities and the capital towns of four prefectures. It is those cities and towns that are the concentration of the AIR from three systems, and the concentration of the organisations of agricultural education, research and production. Only if those centres have been established, the neighbouring areas and remote areas can be developed with the aid of those centres. And, thus, a province-wide network for AIR can be expected to form. The strategic allocation to eleven cities and towns, in terms of subject areas, can be illustrated in Figure 7.2.

However, in assigning responsibility for collection and allocation of information resources, the following should be taken into account:

1. The assessment of the collection strength and subject bias of the libraries and information centres;
2. The identification of geographical characteristics of information resource distribution;
3. The differentiation of sectorial characteristics of information resources distribution; and
4. The identification of the resources already available, both human and material and future possibility etc. (Zhang, 1990)

It must also be pointed out that the emphasis in the distribution will be some cardinal principles but not necessarily influence the library acquisition policy for the materials out of the subjects assigned in order to satisfy their local users' needs.

As with the most of the provincial pattern, Zhejiang has its agricultural library and information system composed of libraries falling into the five categories(five sectors). In the network being designed, the CA programme will be mainly carried out by the two major groups, i.e. education and research groups. And the public library system and Governmental organisation are utilised as a support and back-up. Figure 7.3 illustrates the four types of agricultural library and information centres, and their links. The characteristics of the libraries and information centres in the two major groups have been identified and presented with particular symbols.

First is subject coverage, comprehensive or specialised. By comprehensiveness, the author means that the parent bodies of the libraries are engaged in the research or education on several crops, or on agriculture together with animal husbandry. The provincial academy of agricultural sciences, most prefectural research institutes and agricultural schools fall into this category. By specialised, the author means that the parent bodies of the libraries are engaged in the research or education on one particular crops or plant or animal, such as rice research and tea research institutes.

Second is the administrative level, i.e. provincial, prefectural and county levels.

Third is the Composite Resource Index, which is based on the preliminary assessment of library resources. The Composite Resource Index is the sum of four individual index, i.e. stock level, budget level, book/user ratio and, user/staff ratio (Annexe 7.1.). For each individual

Figure 7.2: Strategic Subject Allocation of AIR in Zhejiang

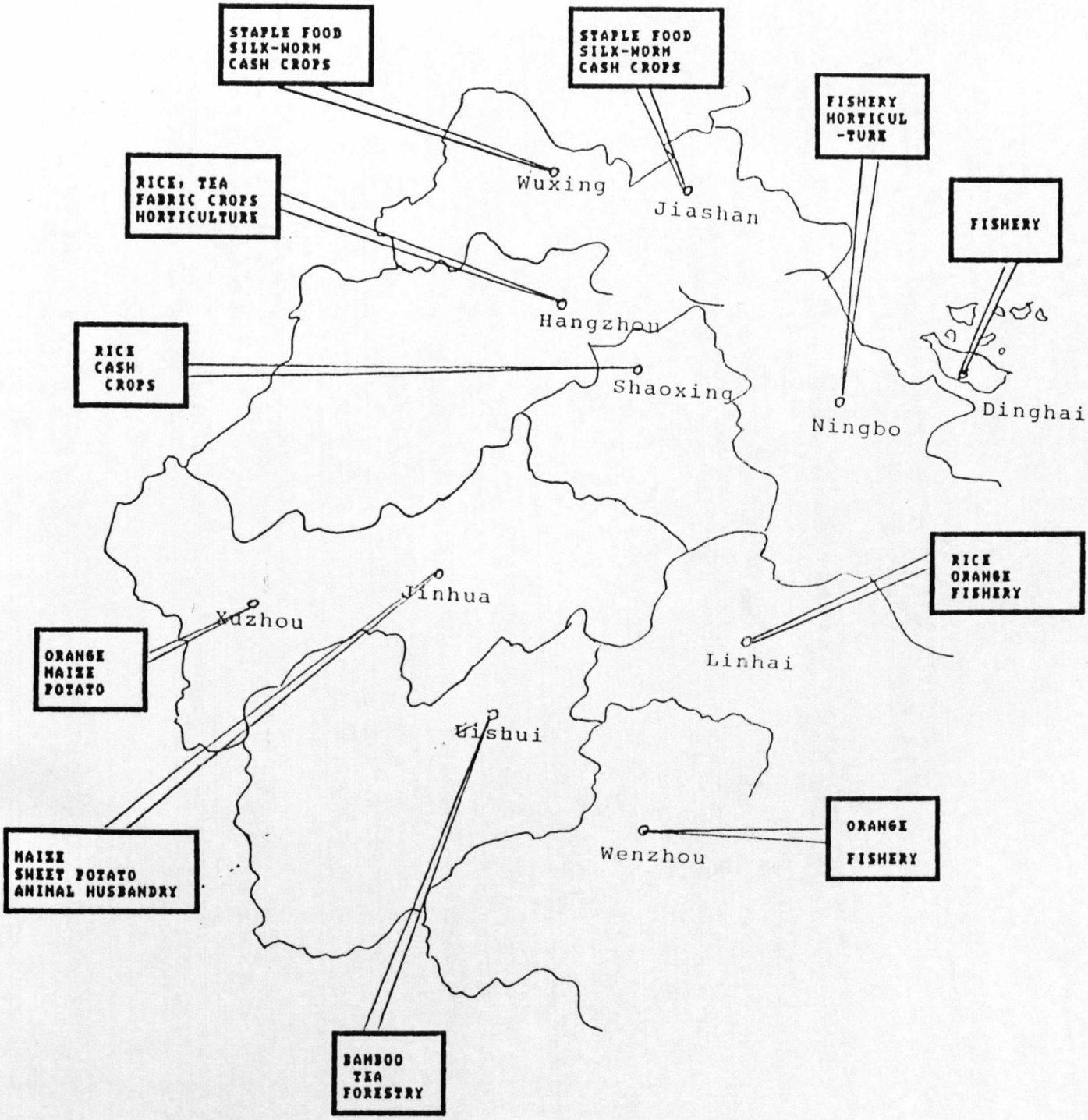
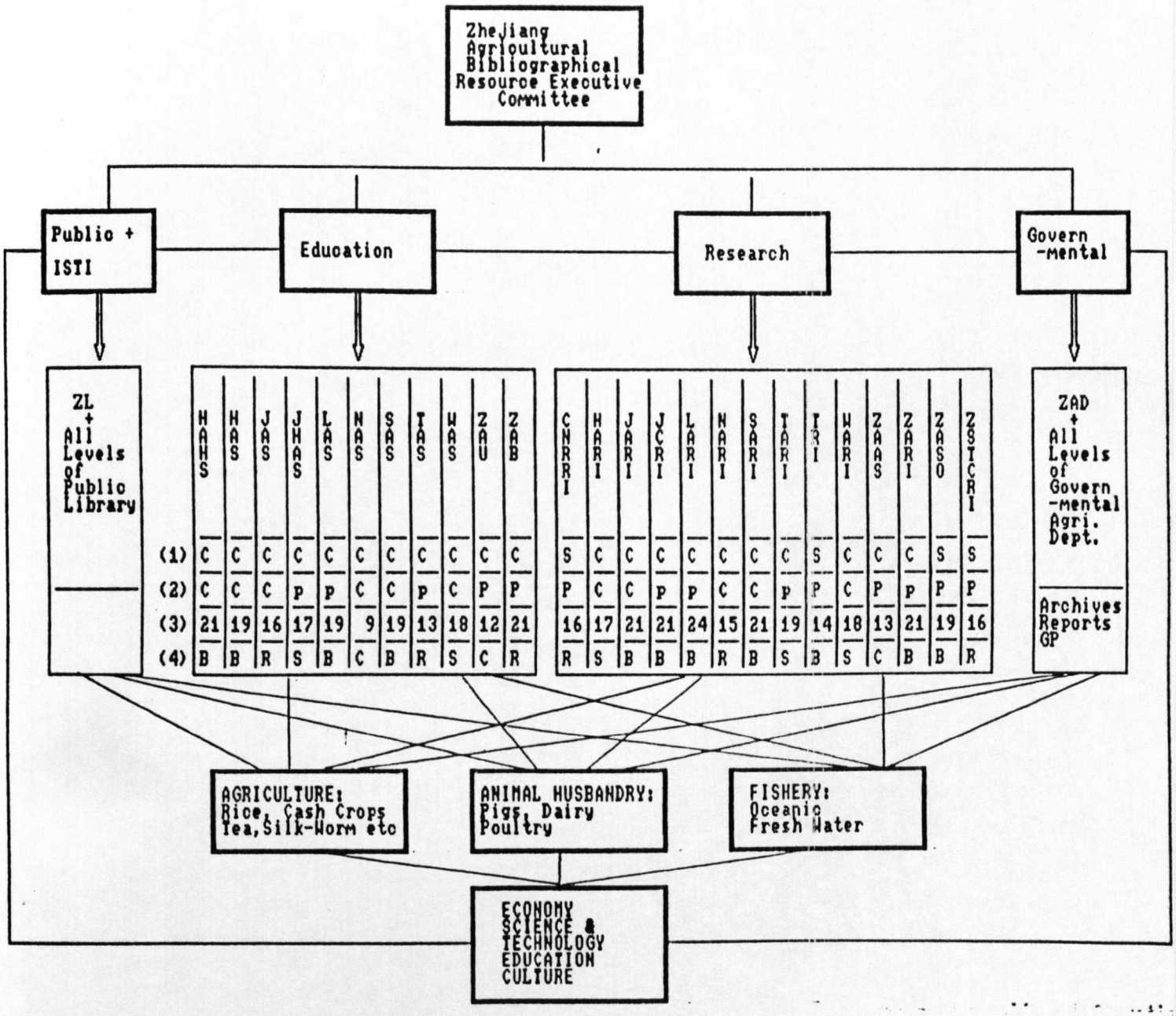


Figure 7.3: Structure of AIR in Zhejiang



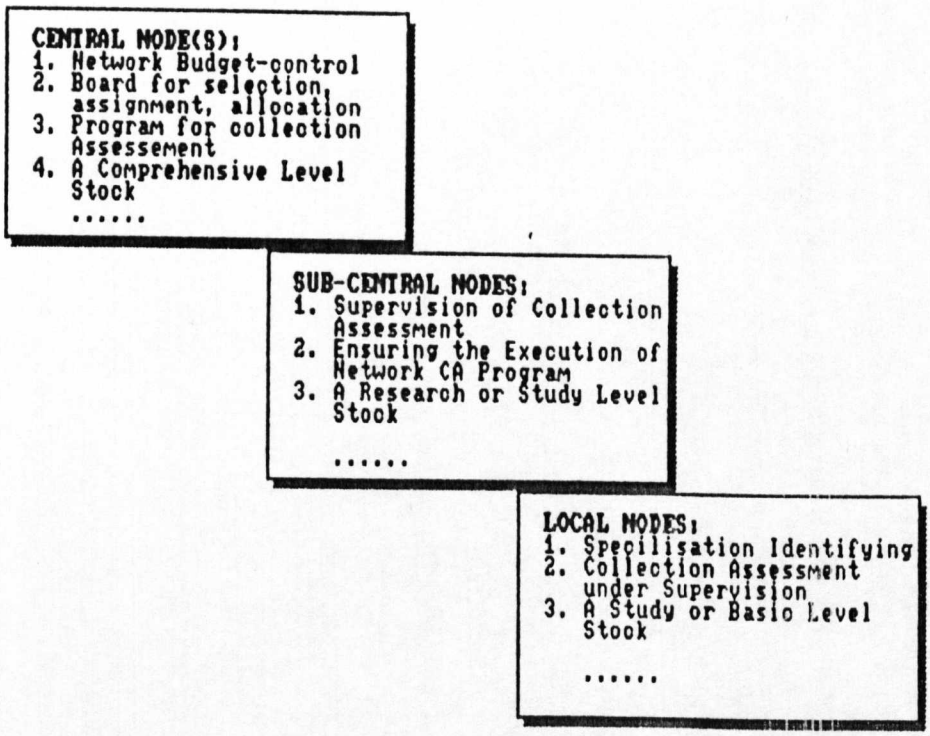
(1) Subject: Comprehensive or Specialised

(2) Administrative Level: Provincial, prefectual & City

(3) Composite Resource Index: stock, budget levels; book/user, user/staff ratios

(4) Assigned Collection Level: Comprehensive, Researoh, Study, Basic & Minimal levels

Figure 7.4: Hierarchy of Responsibility in CAP



index, several scales (levels) has been determined. Rank 1 represents the strongest level or ratio. If a library with strongest stock level, budget level, book/user ratio and user/staff ratio, the composite resource level will be four. There exists no such a library in the system investigated.

Based on the above three identification, the decision about the future collection development can, therefore, be made. And the libraries and information centres can be assigned their objectives and responsibilities reflecting Comprehensive, Research, Study, Basic and Minimum Levels. The scope for those levels is shown in Table 7.1.

Detailed subject specialisation in collection development can be made in accordance with the subject bias of each institutions. And the major responsibilities and supporting responsibilities for those subjects are based on the consideration of the administrative level, specialised degree, collection strength and so on. Figure 7.4 intends to outline the major responsibilities of different levels of centres.

7.2.4 Brief Description of CA Programme in ZALINET

The CA Programme in ZALINET is considered as one of the major functions to fit the network. Its vital importance to resource-sharing network, and its supporting role to other functions should be thorough understood by participating member libraries, network admin-

Table 7.1: Collection Levels & Responsibilities of Libraries

Level	Requirement for Collection	Form of Documents	Organisation of Responsibility
Comprehensive Level	Collecting almost all publications on Agriculture and relevant subjects (of various forms, in various languages) In-depth materials as much as possible	Chinese Documents: Formal Publications Patents Technical Standards Thesis Government Documents ..... Foreign Documents: (by subjects) Agriculture Agricultural relevant subjects	ZAAS ZAU NAS (Over 13)
Research Level	Collecting Publications of major academic school of thoughts, and of major countries	Chinese Documents: University textbook (self-compiled) Internal Publication ..... Foreign Documents: Academic Periodical Conference Proceed-ings Patent ..... Relevant Subject Books	CNRRI TAS NARI ZTCRI JAS ZAB TRI ZASO (Over 16)
Study Level	Selectively collecting basic books and core periodicals	Chinese Documents: ..... Foreign Documents:	JHARI HAS HARI HARI TARI (Over 19)
Basic Level	Carefully select books, and main reference books and core Journals	Chinese Documents:	HAHS, SARI JARI JCRI LARI SARI ZARI (Over 24)
Minimal Level	Collecting the most basic works	.....	County & Town Level

istrators, parent organisations and governmental bodies.

Objectives

CAP in ZALINET intends to achieve the following goals:

1. Developing a comprehensive and largest possible network collection on agriculture to satisfy various types of users in various locations;
2. Providing all users with access to a wider range of materials and services and increasing the fulfiling of user request at different levels;
3. Reducing the duplicates of less-used resources, sharing the expense for expensive items, and avoiding omission of acquisition; and
4. Allowing individual libraries increased specialisation in meeting the primary needs of local users, etc.

Co-ordinated Body

A sub-co-ordinated body (governing authority) under the network Governance Body should be established to assume the role of co-ordinating efforts and to set priorities. The authority should be constituted by those four members: ZAD, ZAU, ZAAS and CNRRI, which is decided by their administrative level, collection strength and representativeness of sectors. This central authority will receive annual and periodic reports from participating members to monitor the implementation of CA plans.

Funding

CA programme will be funded mainly by network its own members. But extra funding from provincial, prefectural or even county governments is necessary and certainly incentives to the network. Activities to be supported should be considered and prioritised. And formulae for funding must be carefully drawn. CA should be funded for a sufficient period of years to become ingrained in a library's budget process.

Commitment

A formal agreements with legal responsibilities should be discussed in the meeting of those participating member libraries. Once the agreement is approved and worked out, a firm and long-term commitment should be complied with by any individual library.

Interlibrary Communication and Physical Access

The following types of communication must be set up to support CA programme in the network:

1. Exchange management information about library acquisitions and circulations by means of frequent meetings;
2. Locate bibliographical holding and status. A union catalogue, especially union list of series should be considered for compilation;
3. Transmit ILL request; and
4. Provide easy and fast physical access to the material should be provided by designing a system involving both moving material around and people around, etc.

Standardisation

Standardisation of the following aspects must be promoted by the network:

1. A list of collection subject areas;
2. A classification scheme for collections;
3. A methodology for collection assessment

7.2.5 CA in three Alternative Programmes

Library science essentially concerns itself with the acquisition, ordering, storage, and availability of knowledge. Only recently has this involved computerisation as a tool. As in other disciplines, however, computerisation has changed the work of librarians as perhaps no other tool used by the discipline. As one critical effect, library automation has opened vistas of networking, so that the whole is becoming greater than the sum of the parts.

To design a cost-effective-benefit CA system, it is important to make a careful comparison between manual and automated (computerised) systems.

Manual CA System

By a manual CA system, the author means a decentralised system, in which all the procedures of acquisition will be run manually and most of them will be carried out in the local libraries.

Semi-computerised CA System

By a semi-computerised CA system, the author means a centralised processing system, in which a processing centre is established. The centre will be equipped with computers performing the functions between the time the material is selected for the collections to the time when it is made available to the user. Such traditional functions as ordering, accessioning, cataloguing, classification and subject analysis, pasting book and spine labels and so on, can all be considered proper activities of co-operative processing centre. Here the author stresses on the first two activities, i.e. ordering and accessioning.

Facilities for the central purchasing of books and other materials include the following:

1. Originating orders by participating libraries;
2. Safeguarding against unnecessary duplication of expensive and specialised material, with the opportunity of reviewing duplicate orders;
3. Reporting to libraries of action taken and reasons for any delay in supplying orders; and
4. Providing for chasing unfilled orders.

Computerised CA System

By a computerised CA system, the author means an on-line acquisition system with the access to all network members, network centre and to booksellers and publishers, or an acquisition system with all the local libraries having automated sub-acquisition systems. An outline of an ideal on-line acquisition system should be able: —

1. To search the library's own and other libraries' bibliographic files to determine the status of the items;
2. To search a file of bookseller or publisher details;
3. To place on order on-line directly to the bookseller/publisher; and
4. To provide very detailed financial information in a variety of ways etc.

It has to be pointed out that the feasibility of on-line acquisition system linked to booksellers/publishers depends very much on the availability of the databases produced by booksellers/publishers. It is noticeable that the increasing automation in the book trade and library acquisition systems is leading to a new type of bookseller/library interface and relationship.

Before setting up an on-line computerised CA system, it is imperative to automate the local acquisitions first. Therefore, it is of importance to have a close look at the library automation of acquisition.

In western countries, the primary motives that prompted libraries to investigate automated acquisitions systems in the 1980s appeared to be the hope of realising cost reduction or cost containment, speeding the receipt of materials, improving fund control, expanding single function systems into integrated systems and being in the forefront of librarianship.

At the beginning of the 1980s, the concerns of the acquisitions librarian in the advanced countries were no longer primarily associated with ordering, but with collection development and sound management of funds. The problem for most libraries is how to make the best collection development decision in light of scarce resources and the mission and goals of the parent organisation. It has frequently been said that the most significant part of acquisition work—that which involves the planned selection of material, both new and old, best calculated to strengthen the institution's resources—takes place before the books are actually ordered. Modern acquisitions systems are increasingly expected to do more than provide purchase order writing, accurate outstanding order information, timely reports and good funds control. They must also become tools for selections by providing detailed collection information. (Boss, 1982)

Attempts are made to identify the means and equipment involved in the CA for three programmes. They can be summarised in Table 7.2.

CA programme needs a detailed optimum allocation of information resources, which can only be fulfilled by the construction of both descriptive and mathematical models. The latter can provide quantitative solutions. The next section discusses the process of mathematical model of CA.

7.3 Models of Optimum Information Resource Allocation—Mathematical Models

7.3.1 Defining Performance Criteria

Performance criteria usually reflect the objectives to be fulfilled and the problems to be solved. On reviewing objectives of CA, we find that they may entail the following major aspects:

1. The largest possible comprehensive network collection, in other words minimum omissions;
2. Minimum duplicates; and
3. Specialisation in collections etc.

The largest possible comprehensive network collection size permits a high degree of access to material by network users, which is one of the desirable features of the network. But unnecessary duplicates, either between libraries or within a library wastes limited budgets.

Table 7.2: Means & Equipment used in Each Steps for three Programme (CA)

(Co-operative Acquisition)

Activity Description	Program One	Program Two	Program Three
Network Level			
1) Interlibrary Communication	M&M[1]/Stationary	M&M/Stationary or Telephone	EM[2]&TC[3]/Computer &telecom
2) Collection Assessment	Manual	Manual	Manual/Computer
3) Policy & Paln Making	Meetings	Meetings	Teleconference /Computer&telecom
4) Co-ordination & Control	Manual	Manul	C/Computer & Software Telecom
Local Library			
5) Selection	Manual	Manual	Computer
6) Ordering Routine	Manual/ Stationary	Computer & Stationary Teletypewriter	Computer, Telecom & Stationary & Teletypewriter
8) Checking Arrivals	Manual	Manual	Manual
7) Fund Accounting	Manual/ Calculator	Computer	Computer
9) Book Accessioning	Manual /Stationary	Munual /Stationary	Manual /Stationary
10)Book Distribution	Manual	Manual	Manual

It is important to bear in mind the following sequence questions: what is the largest collection size the network can possibly afford to acquire subject to the budget constraints? Which is more cost-effective, acquiring or borrowing the less-used and expensive items via ILL outside network? Is it desirable and convenient to local users if all the budgets are spent on acquiring unique titles which, therefore, results in too many ILL transactions and time delay in satisfying the requests in the network? What is a reasonable queue length for popular items in the local libraries? All these above problems require some careful consideration and trade-off in the decision-making process for CA.

The consideration should reflect the objectives of CA, and focus on solving the above problems. Such a consideration, thus, can help reach optimum solutions for CA policies in the planning and programming. To reflect the objectives of CA, we first need to identify and determine corresponding performance criteria and measures.

Four performance criteria have been identified to describe how well the CA policies will operate. Those criteria are: —

1. Network material accessibility;
2. Cost-effectiveness of ILL (from other systems);
3. Geographical accessibility; and
4. Local availability.

Network Material Accessibility

Network Material Accessibility can be defined as the capability of a network to offer its collection for being used in variety of ways, i.e. borrowing, retrieving and consulting. The material includes different natures of information for research and teaching etc.

The major concern of this objective criterion is to determine 1) the optimum total network collection size, i.e. the solution about how many titles the network will acquire and store; 2) the optimum collection allocation among the subjects or classes; i.e. the solution about how many titles in each subject class a network should acquire and store; and 3) the optimum collection allocation among the nodes; i.e. the solution about how many items each nodes should acquire and store.

Cost-effectiveness of ILL outside the Network

Cost-effectiveness of ILL outside the Network can be defined as the decision about borrowing instead of acquiring when borrowing at the cost lower than that of acquiring the items requested.

Apparently, on one side, due to the rapid growth of publications and inflation, tightened budgets make the network unable to acquire all the titles requested so ILL become inevitable.

On the other hand, for some less-used and expensive items, it might be cheaper to rely on ILL and not to acquire them at all. Thus, in a sense, ILL outside becomes a cost-effective device for the network. Such mechanism as usage study, citation study and operation research etc. will be helpful in making a decision about what groups, or more detailed what items fall into the scale to be not acquired by the network (Brookes,1979; Zhang, 1986). And the network will satisfy the requests on those items through ILL outside.

Geographical Accessibility

Geographical Accessibility can be expressed as a reasonably short distance covered to satisfy an ILL request. In other words, it can be defined as the ability of satisfying the requests locally, if not, via ILL at the least possible delay. Here the meaning of the distance does not necessarily mean the actual distance. Since the difference in actual distance between two libraries does not cause significant difference in delivery time within a province, we, therefore, can ignore the geographical distance and concern about relay time units only.

Assuming that no union catalogue is available in the system concerned, ILL then becomes N-body transaction. In such a type of transaction, *relay times* become a major factor, related to the number of copies of same title and relay route etc. In a N-body transaction environment, an increased number of copies for same titles in the network (excluding duplicates in the same library) result in higher fill rate and fewer relay times from the ILL requesters' point of view, and greater degree of local satisfaction and convenience from local users' point of view, if the local library happens to be allocated one copy. The performance criteria, Geographical Accessibility can therefore be used to work out the optimum overlapping degrees between libraries. In other words, different overlapping degree for popular or less-used titles will bring out cost-effective solutions with reasonable relay times.

Local Availability

Local Availability can be defined as the probability of users' request being satisfied by local stock.

A library circulation system is a queuing system. When several users require the same title at a particular period of time and the number of request exceeds the number of copies available or the copies are already on loan, some of users have to wait. It is obvious that keeping a user to wait for a long period is undesirable. Some strategy needs to be work out to reduce the waiting time. Among them, one fundamental strategy is increasing the number of the copies of popular titles in the local libraries. The increased number of copies of same title in the library will reduce the wait time and improve the probability of satisfaction. Therefore, Local Availability can be used to work out an optimum solution about what is the optimum duplicated rate for different popularity classes of titles to avoid undesirable waiting time and disappointment.

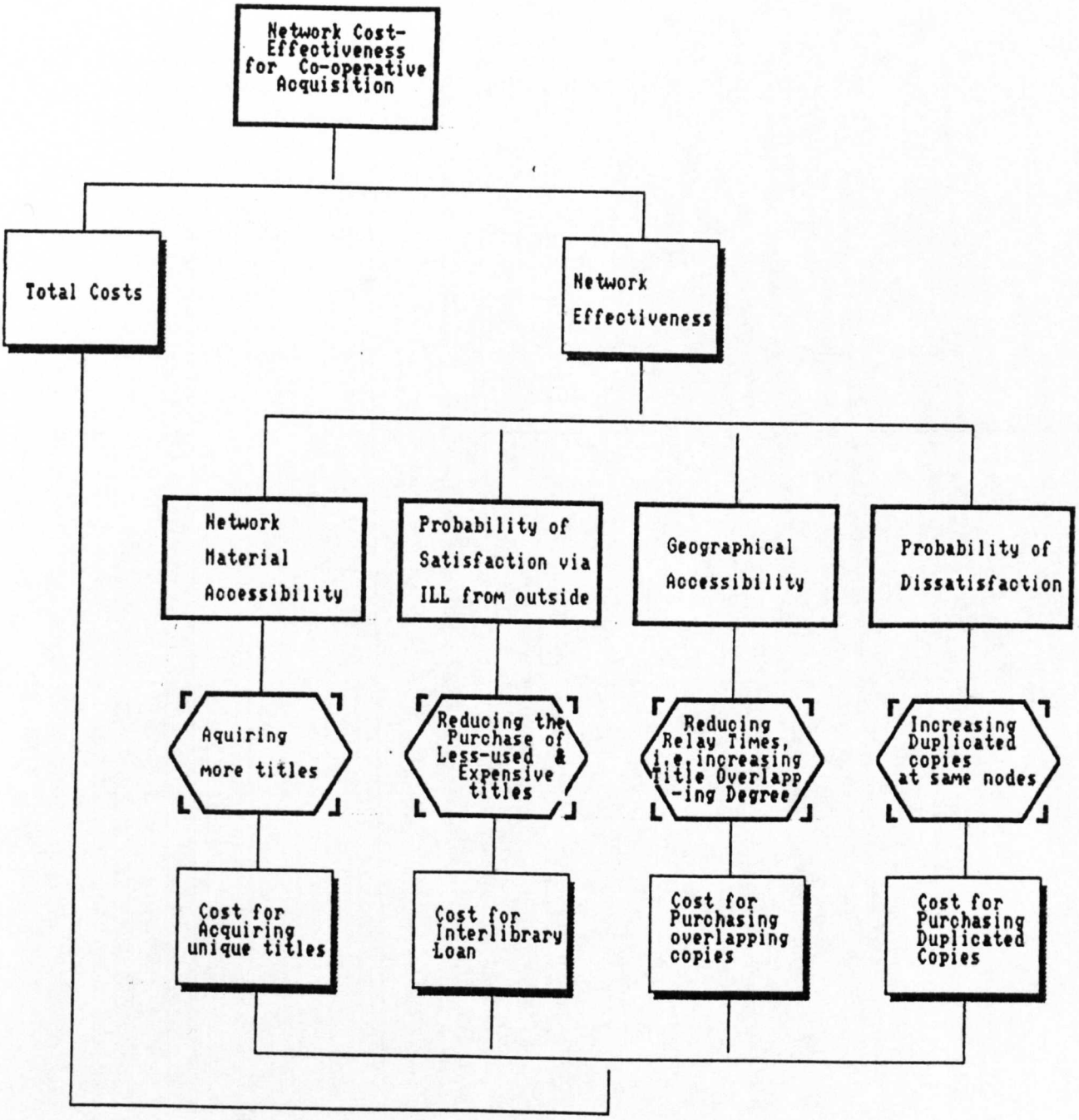
Relationship of the Performance Criteria

The above four criteria are categorised as Network CA Effectiveness Measures since they can be measured in terms of how well the acquisition policy will operate and satisfy the demand placed by the network users. As it has been mentioned in their definitions, the four criteria will allow the network administrator to work out a reasonable acquisition programme with 1) optimum collection size; 2) optimum rules for acquiring or borrowing; 3) optimum allocation of limited funds between collection size and duplicated copies both among libraries and within libraries; and 4) optimum allocation of collection among nodes and subjects. To maximise each individual objective requires a budget for each. For instance, to assure the biggest possible collection coverage, the budget to be involved is bound to be huge. Actually, because of the growth of publication and inflation, it is unlikely that the network will able to acquire 80% of the current publication on average. On other hand, for some less-used and expensive items, there remains a question whether it is cost-effective to acquire them or not. ILL from other system probably is more preferable for some items, in terms of cost-effectiveness. Meanwhile, the budgets need to be allocated to assure certain level of Local Availability and reduce time delay via ILL within the network. In other words, it would be more desirable if the local libraries can satisfy their own users' requests on some popular items by their own stock, or if not, a minimum relay times is expected via ILL. To express the criteria of Local Availability, an opposite criteria is used, namely Probability of Dissatisfaction. To achieve both goals, i.e. Geographical Accessibility and Local Availability, we need to increase the number of duplicated copies of the title either among libraries or within libraries, which compete the acquisition budget with the policy of acquiring more titles.

To summarise, the four performance criteria, the first concerning acquiring more unique titles; the second concerning acquiring or borrowing less-used and expensive items via ILL outside, and the last two both concerning acquiring more copies, compete the budgets with one another. For each of these individual performance criteria, it has its own cost-effective measures. While the overall cost-effectiveness of the CA programme can be expressed as the relationship between level of overall performance (effectiveness) and the costs involved in achieving this level. Several alternative methods may be used to obtain a particular performance level. The least expensive alternative is the most cost- effective one. Figure 7.5 shows the following relationship:

1. Between the overall network performance (effectiveness) for CA and the individual performance (effectiveness) measures;
2. Between the individual performance criteria and individual performance;
3. Between the individual performance and the costs to achieve certain level of performance; and
4. Between total cost and the overall effectiveness.

Figure 7.5: Relationship Between Cost & Effectiveness for CAP



7.3.2 The Formulation of the Objective Functions

Material Accessibility

In mathematical terms, *Material Accessibility* can be defined as the percentage by which the total number of requests on the titles accessible in the network occupies in the total number of requests on the titles universally available.

The formulation of this criteria should take consideration of such a factor as the number of requests on different classes from the users, in other words, the popularity of the books. It is obvious that the more popular a book is, the more requests will be posed on it, and the heavier it will be used and vice versa. Therefore, the more popular books should have more weight and the priority to be acquired.

Based on the above definition and underlying philosophy, the criteria can be expressed as

$$\frac{1}{Tu_t}(\sum_{i=1}^{I}\sum_{j=1}^{J} I_{ij}u_{ij}) \times 100\%$$

Here, the author intends to maximise the objective in order to achieve optimum solution. It is usually the case that because of the budget constraints, we are not able to purchase the number of titles as much as we wish. To guarantee a minimum satisfactory level both at the network level and local library level and to keep the balance between the libraries, there should be some minimum title requirements for the network and minimum item requirements for each library. Again there should be some minimum title requirements and maximum title restrictions for each classes to keep the balance between classes. Therefore, the problem can be formulated as follows:

$$Max\{[\frac{1}{Tu_t}(\sum_{i=1}^{I}\sum_{j=1}^{J} I_{ij}u_{ij})] \times 100\%\}$$

s.t.

$$[\sum_{i=1}^{I}\sum_{j=1}^{J} I_{ij} - (\sum_{i=1}^{I}\sum_{j=1}^{J} I_{ij}) \times O\%] \geq I_n \quad \text{(Total Title Constraints)}$$

$$I_i^L \leq [\sum_{j=1}^{J} I_{ij} - (\sum_{j=1}^{J} I_{ij}) \times O\%] \leq I_i^U \quad \text{(Titles of Each Class)}$$

$$\sum_{i=1}^{I} I_{ij} \geq I_j^m \quad \text{(Title of Each Library)}$$

$$\sum_{i=1}^{I} cI_{ij} \leq B_j \quad \text{(Budget Constraints in Each Library)}$$

$$\sum_{j=1}^{J} cI_{ij} \leq B_i \quad \text{(Budget Constraints for Each Class)}$$

$$I_{ij} \geq 0$$

I is the number of title classes;
J is the number of participating libraries;
T is the total number of titles universally available;
u_t is the average number of requests on titles universally available;
I_{ij} is the number titles in class i to be allocated to library J;
u_{ij} is the average number of request on class i from library J;
$\sum_{i=1}^{I} \sum_{j=1}^{J} I_{ij}$ is the total number of items in the network; including the overlaps between libraries;
$O\%$ is the average overlap rate of class i from J libraries;
I_n is the minimum title requirement for the network, i.e. title constraints for network;
$O_i\%$ is the average overlap rate of class i between libraries;
I_i^L is the lower-level title constraints in class i;
I_i^U is the upper-level title constraints in class i;
$(\sum_{j=1}^{J}) \cdot O_i\%$ is the number of title in each class to be acquired;
$\sum_{i=1}^{I} I_{ij}$ is the number of items library J is going to acquire;
I_j^m is the title constraints in library j;
c is the average cost of each title despite of classes;
B_j is the budget constraints of library j for acquisition of books.

The detailed explanation can be found in Appendix B.

Cost-effectiveness of ILL outside

Assuming that the network will attempt to meet all demands of their users, the budgets will have to cover the following costs

1. cost of acquiring titles (including overlapping copies and duplicated copies);
2. ILL costs for borrowing items that network fails to acquire (because of budget restriction).

What balance between acquisition and ILL from outside will minimise the sum of these costs without reducing the user satisfaction rate? The acquisition policy could be defined as acquiring as many titles as possible until reliance on ILL become cheaper.

Therefore, the cost-effective of ILL from outside can be formulated as the proportion of request satisfied by outside network at the cost lower than that of acquiring the items requested:

$$\frac{\sum_{l=1}^{L} I_l u_l}{\sum_{t=1}^{T} I_t u_t} \times 100\%$$

It is subject to the following constraints

$$\sum_{i=1}^{I} I_i C_i + \sum_{l=1}^{L} I_l C_l \leq C \qquad \text{(Total Costs for Acquisitions and ILL)}$$

and

$$C_l \leq C_i \qquad \text{(ILL costs less than purchases cost for specific title)}$$

$$\sum_{i=1}^{I} I_i + \sum_{l=1}^{L} I_l \leq \sum_{t=1}^{T} I_t$$

where

$\sum_t^T I_t$	is the total number of titles universally available;
u_t	is the average number of request on the titles universally available;
$\sum_{l=1}^{L} I_l$	is the number of titles which is not going to be acquired but can be borrowed via ILL at cheaper cost;
u_l	is the average number of request on the titles which is not going to be acquired;
$\sum_{i=1}^{I} I_i$	is the number of titles which is going to be acquired in class i;
C_i	is the unit cost of purchasing one item in class i;
C_l	is the unit cost of ILL per item;
C	is the total costs of purchasing and ILL charges.

Geographical Accessibility and Local Availability

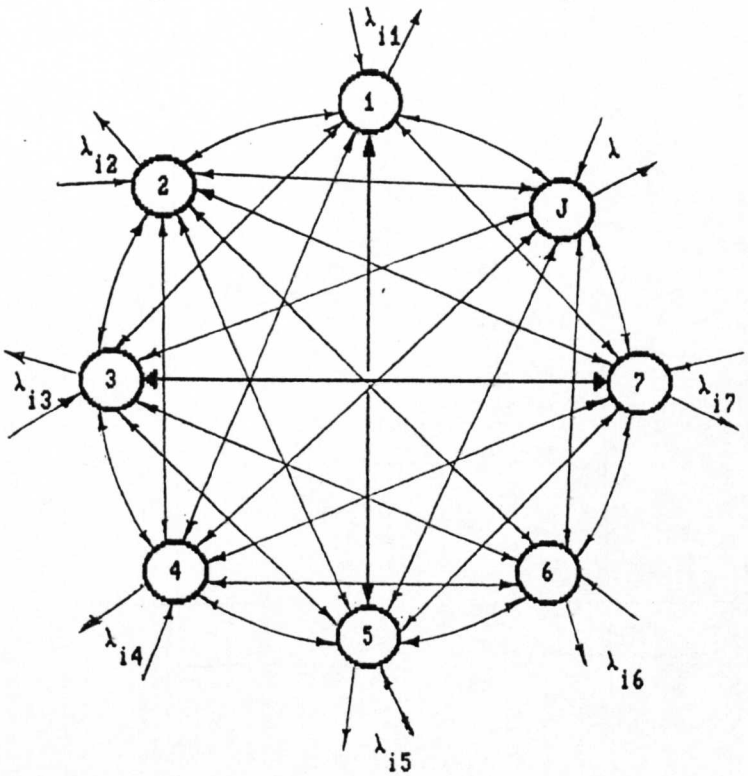
When formulating these objective criteria, the queueing theory is applied. Therefore, it is necessary to give a brief description of the queueing system.

As it is shown in Figure 7.6, title i request enter the network at library j at an average rate of λ (request/unit time). Here we do not distinguish the local requests from ILL requests. Then we assume that at node j there are average $n(b_{ij})$ copies of titles in class i. In this case we assume that every arrival, if he does not find the book available gives up, and does not try again(in other words we assume complete balking and thus no queue).

Often queuing system are categorised using a notation of the form (x/y/z):(u/v/w) where each of these six symbols is defined as follows:

1. x = inter-arrival time distribution

Figure 7.6: Illustration of Queueing Network



2. y = service time distribution
3. z = number of parallel servers
4. u = service discipline
5. v = maximum number of customers allowed
6. w = size of customer population

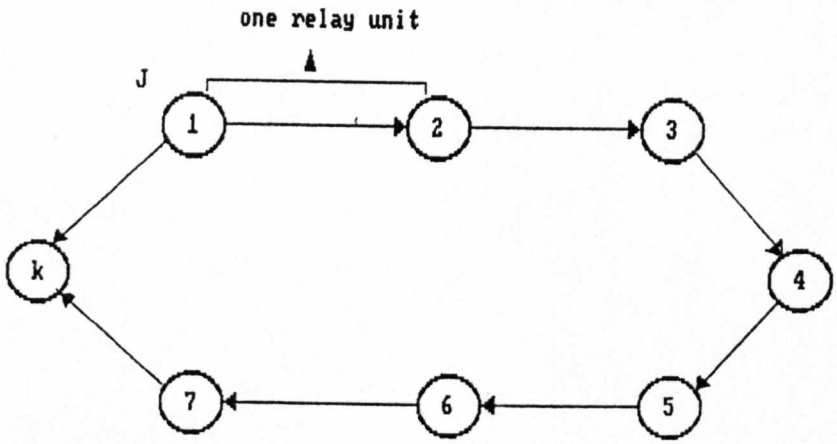
In this case, we assume that customers arrived randomly and the time at which the next customer arrived is unrelated to the time when the last customer arrived, then x = M, where M stands for Markov and denotes arrivals that are a Poission Process. y = G for services time with a general distribution(or y = M for exponentially distributed services times). And $v = \infty$ and $w = \infty$

The service discipline u = FCFS, i.e. first come-first served, but for ILL queue system whether the pre-emptive priority(u = PRP) discipline for the local requests will be adopted should be decided (Rouse and Rouse, 1980).

Georgraphical Accessibility

Here, only non-computerised system is concerned.

Figure 7.7: ILL Relay Route



First, the author assumes that the distance between the request library and resource library is d_{ij}. Before it is satisfied by node j, the request may have been relayed n times. The author also assumes that the request will be sent to the "nearest library" first, if it fails to be satisfied, then relayed to the next library. The direction of the routes is clockwise. Since the difference of mailing time is not so distinguished in a province, the author assumes that the distance between any two close (neighbouring) nodes are the same. Therefore, the relay times n become major concern. (Figure 7.7)

Here, only the case of N-body transaction is considered. That is to say that no union catalogue is available in the network thus the request has to be relayed by certain relay route if it can not be satisfied by the library it enters at the first place. There exists two cases in the N-body transaction: in the first case, when i class request enter jth library, the library fails to satisfy the request becuase of either the inaccessibility or unavailability, and the library relays the request to another library. By inaccessibility, the author means that the titles requested are not collected in the library entered; By unavailability, the author means that the titles are collected in the library, but they are on loan by other users at the moment of entering. That is to say that only when the probability of availability is high, the request is most likely to be satisfied immediately. In this case, we can only take consideration of the probability of availability. Thus,

$$P'_{ijk} = \frac{\mu_{ij}}{\lambda_{ij} + \mu_{ij}} \tag{7.1}$$

and

$$P_{ijk} = P_{ij1} \times P_{ij2} \times \ldots \times (\frac{\mu_{ij}}{\lambda_{ij} + \mu_{ij}}) \tag{7.2}$$

In the second case, we only take consideration of the probability of accessibility. Once the title i is accessible at node k, the request will eventually be satisfied since it join the queue to wait. Therefore, we can ignore the probability of availability. In that case, the probability of accessibility at kth library is

$$P_{ijk} = P_{ij1} \times P_{ij2} \times \ldots \times P''_{ijk} \tag{7.3}$$

If there are m copies of title i available in the network, the probability of accessibility at first library is

$$\frac{m}{J-1}$$

at rth library is

$$P''_{ijk} = (1 - \frac{m}{J-1})(1 - \frac{m}{J-2}) \times \ldots \times (1 - \frac{m}{J-r+2}) \times \frac{m}{J-r+1} \tag{7.4}$$

For convenience, the author assumes that there are I subject classes and that the jth library start a class i request with probability, P_{ij}. Here, the author only takes the second case into account, i.e. ignoring the probability of unavailability. The author further assumes that the resource distribution is uniform distribution. By uniform distribution, we mean such a distribution that all J libraries have equal value of P_{ij}, i.e. m/J, while P''_{ijk} can be calculated by Formula (7.4).

With an uniform resource distribution, the appropriate policy is to send a request to the nearest library, and if not satisfied there, to refer it to the next nearest library, and so on until the request is finally being satisfied. It is obvious that this probability increases as the number of copies of the same title in class i within the network increase, i.e. more nodes owning the title. Here more than one copy owned by the same node has been assumed to have the same effect as one does, i.e. same probability for the node to satisfy the request. Therefore, only one copy of the titles will be counted for each node.

Based on the above assumptions, therefore, the Expected Distance for a request on title i to be satisfied can be expressed as

$$D_i = \frac{\sum_{j=1}^{J} [\sum_{k=1}^{K} d_{jk} P''_{ijk}] P'_{ij} \lambda_{ij}}{\sum_{j=1}^{J} \lambda_{ij}}$$

where

d_{jk} is the distance between the request node and resource node;
P'_{ij} is the Probability of i type request initialised at node j;
P''_{ijk} is the Probability of i type request initialised from node j to be satisfied by node k, which can be calculated by formula (4).
λ_{ij} is the number of i class request at node j;
$\sum_{j=1}^{J} \lambda_{ij}$ is the sum of i class request in the network.

The Expected Distance to satisfy a request of any type is given by

$$D = \frac{\sum_{i=1}^{I} D_i \lambda_i}{\sum_{i=1}^{I} \lambda_i}$$

Where

λ_i is the number of class i request in the network;
$\sum_{i=1}^{I} \lambda_i$ is the sum of I classes request in the network.

The minimisation of the Expected Distance can be carried out by integer programming (Appendix B).

Local Availability (Probability of Dissatisfaction)

Local Availability is defined as the probability of users' request being satisfied by local stock. To avoid some complication, an opposite measure, Probability of Dissatisfaction will be used when formulating a queueing system.

The author assumes that the network has J member libraries and there are I request classes. Class i request enter the network at library j at an average rate of λ_i(request/unit time). The average return rate of each library for class i is μ_i. Here, $\frac{1}{\mu_i}$ is mean loan period. If assuming that the borrowing is one immediately after another, thus $\frac{\lambda_i}{\mu_i}$ is mean number of users can read class i book at a given time.

According to Morse's formula, we can assume that when one copy is circulated, the copy is not on shelf (not available) a fraction of $\frac{R_{ij}}{\mu_{ij}}$ of the year, where R_{ij} is the circulation rate per year and $\frac{1}{\mu_{ij}}$ is the mean circulation time(the loan period). During this time persons have come looking for the book and having found it missing from shelves, give up and leave. The probability of dissatisfaction, thus can be

$$P_{ij} = \frac{\lambda_{ij}}{\lambda_{ij} + \mu_{ij}}$$

When a second copy of a book is made available for circulation, what happens? Since arrivals of prospective borrowers are at random and since the two copies circulate independently of each other, there will still be times when both copies are out of library and some potential

borrowers will still be disappointed. The probability of dissatisfaction for title at node when two copies circulate is

$$P_{ij}^2 = \frac{(\frac{\lambda_{ij}}{\mu_{ij}})^2}{2[1 + \frac{\lambda_{ij}}{\mu_{ij}} + \frac{1}{2}(\frac{\lambda_{ij}}{\mu_{ij}})^2]}$$

If the average number of copies for each title of class i is $n(b_{ij})$ at library j, therefore, the probability of dissatisfaction for titles in class i at library j will be

$$P_{ij}^n = \frac{(\frac{\lambda_{ij}}{\mu_{ij}})^n}{n!(1 + E_n)}$$

Where

$$E_n = \sum_{n=1}^{N} \frac{1}{n!}(\frac{\lambda_{ij}}{\mu_{ij}})^n$$
$$n = b_{ij}$$

And the average Probability of Dissatisfaction for each title in class i in the network when average n copies for each node are circulated

$$P_i^n = \frac{1}{\lambda_i} \sum_{j=1}^{J} P_{ij}^n \lambda_{ij}$$

The author intends to minimise the Probability of Dissatisfaction subject to the budget constraints hence to obtain the optimum solution about the average number of duplicated copies for each title in class i which each library should keep, therefore, an integer programming model can be formulated as follows:

$$Min\{p_i^1 x_1 + p_i^2 x_2 + \ldots + p_i^n x_3\}$$

s.t.

$$x_1 + x_2 \ldots + x_n = 1 \tag{7.5}$$
$$x_k = \{0, 1\} \tag{7.6}$$
$$k = 1, 2, 3, \ldots, n \tag{7.7}$$
$$C_i^1 x_1 + C_i^2 + \ldots + C_i^n x_n \leq B_i \tag{7.8}$$

Appendix B explains the variables and the way of solving the problem.

7.3.3 The Usefulness of the Single Objective Function

Following the planning cycle, there are two important stages, i.e. cost analysis and trade off, in which some sound vehicles are expected.

The single objective functions as the mathematical expression of the individual performance (effectiveness) criteria, can be a useful objective tool for cost analysis and trade-off. They can serve two main purpose:

1. Helping determine the cost requirements of each objective (activity) by setting desired goals (objective measures), thus achieving analytical solutions;
2. Then taking the allocation results (after AHP process and trade-off between cost requirement and budget level) to achieve optimum solutions of those effectiveness measures. (Zhang, 1990)

The first purpose is explained by the following paragraphs while the second is left for the further research when the required numeric data become available.

Analytical solutions are usually obtained on basis of different assumptions, and we can choose the solution which reflects the desired or reasonable objective measures.

Analytical Solution of Geographical Accessibility (Expected Distance)—An Illustrative Example

The author first assumes that a class i request from node j is sent to nearest library first. The request is probably satisfied in the first library, if not it will be relayed to the second, the third and the fourth etc until it is finally satisfied in the library k. The probability is random but conditional. The distance covered to satisfy the request i from node j to node k is denoted as D_{ijk}. The distance between two close nodes is one unit of relay times. Therefore, the distance, i.e. relay times between node j to any of node k can easily be calculated. (Annexe 7.1.)

The probability of class i request initiated from node j to be satisfied by node k can be calculated by formula (7.4). For the purpose of analysis, the value of for node k to satisfy class i requests were calculated when various numbers of copies, increased by five each time are owned by the network. Multiplying the probability, P''_{ijk} by the corresponding relay times, then summing them up, we thus obtain the product of probability and relay times under the different circumstances. The product of these two values is actually the Expected Distance for a class i request initiated from node j to be satisfied by node k. Annexe 7.2 shows the value of the Expected Distance. Since the author has assumed that the resource distribution is uniform, that implies that each node has the equal probability of initiating a class i request, which is related to the numbers of nodes and numbers of copies.

The costs involved can be divided into three main types, i.e. costs for acquisition of books and costs for processing of interlibrary requests (mainly relaying) and costs of user's waiting.

In this example, only the costs of the first two will be counted. From Annexe 7.2, we can see that costs for acquisition increase as the number of copies increase, while the processing cost decreases as the number of copies increase. The combined costs are defined as the cost of Geographical Accessibility. The processing cost was converted from the human effort by using appropriate arbitrary salary figures. Overheads were added to this to cover both direct and indirect costs. As an assumption, the salary figure of 150 (Yen) per month and overheads figure of 50% of salary have been used. Thus the conversion factor was 150 (Yen) + $\frac{1}{2}$ overheads = 225 (Yen) per month. Using the figure of 23 available man-days or 184 (23 $\times$8 = 184) man-hours of effort per month, a conversion factor of 9.78 (Yen) per man-day or 1.22 (Yen) per man-hour was derived. If we assume that average processing time for relaying a request is a quarter of an hour, i.e. 0.25 hour, the average cost for relaying a request, therefore can be calculated as follows: $C_b = 1.22 \times 0.25 = 0.31$ (Yen)

Annexe 7.3. presents the difference of Expected Distance, D_d, the difference of relay times, R_d and the difference of the costs, C_d when every five copies are increased. If C_d divides by D_d and R_d respectively, the increase of the unit cost per Expected Distance unit and per relay unit at different cases were derived. It can be seen clearly from the table that at the low basis, i.e., as number of copies increased from one to five or from five to ten, the relay times and Expected Distance reduce dramatically. While at high basis, i.e. number of copies increased from twenty to twenty-five, the reduction of the relay times and the Expected Distance is not so marked. And the cost to reduce the unit Expected Distance and relay time is getting higher from the low basis to the high basis.

The cost would be the lowest if one copy of a particular title is to be collected by the network. However, it is obvious that such a long Expected Distance or so many relay times is not desirable, and therefore trade-offs between effectiveness and cost are needed.

The consideration of both number of request (Popularity Class) and relay times is essential. If multiplying number of request by average relay times, we can then choose the desired product value or reasonable target for different popularity classes. By referring back to the corresponding overlap degree, we thus obtain the desired number of copies (or reasonable target) for each popularity class, then calculate the acquisition costs and relay processing costs for each class.

More details will be given in the cost-effective analysis of stock purchase (Chapter Eleven).

It is hoped by the author that the efforts made to identify of design issues and principles, and the construction of both descriptive and mathematical models for CA will bring out a helpful guideline to the network being designed. The actual implementation will require some more detailed and micro-level policies.

Chapter 8

Design of ILL-UC System

8.1 Introduction

Interlibrary Loan is of great and growing importance. The reasons for this are obvious: there has been a great growth in the number and cost of publications, and a comparable growth in education and research and development at all levels has stimulated demand for publications. To the large output of developed countries has been added the rapidly growing output of developing countries. Meanwhile, demand has been stimulated by improvements in bibliographic access, when the use of automation has both made the production of new bibliographic tools possible and added a new dimension with direct on-line access to computer stored reference (Line, 1980). Users are thus being presented with a larger number and wider range of references, with a speed that has led them to be less content with slow access to documents to which they refer. At same time economic pressures have forced many libraries to cut down on their acquisition. In consequence, libraries have been becoming increasingly unable to provide their users with all the publications they wish to use, and have had to draw more and more on the resources of other libraries. Interlibrary loan, once a marginal activity that was regarded as a favour rather than a right, has become an essential feature of the scene in both developed countries and developing countries.

Union catalogues are also the traditional means by which libraries make their holdings known and accessible outside their own community, usually via ILL. Their major function has been to facilitate access to library collections by resource sharing and co-operation among a number of libraries and information centres which are separately managed and administered.

Resource-sharing, together with ready access to documents, becomes more important as the amount of information published in one or other form increases. Indeed, there sometimes appears to be an inverse ratio between the amount of information published and the extent of the resources available to acquire, house, maintain and adequately service it. Hence the capability not only to list but also to locate published information has become necessarily a major preoccupation of libraries.

As two major conventional functions of network, ILL and UC are closely related to each other. It is important to understand the relationship between the two functions when designing the network. It seems reasonable to design the two system together since they overlap a great deal.

8.2 Interlibrary Loan

8.2.1 Overview

Actually, ILL and document delivery systems are not new phenomena. Libraries have always relied on each other to help to cater for the needs of their users. Co-operation is part of the library tradition, and in some way, ironically, it is in those countries with the best-established library services and the richest libraries that ILL schemes are also best developed.(Wood, 1988)

In the western countries, a more dedicated approach, i.e. document delivery, has appeared. Document delivery now involves the wider sector dedicated to this activity than does interlibrary lending. The business of ILL has gradually been transformed, not only by the greater range and amount of material available, but also by the wider needs of users. Technology, in the form of photocopying equipment, has made it easier to provide copies instead of originals, and computer technology has made information on what is available, and where, much more accessible.

Line al et. (1980) summarised the main features of existing ILL practices in the world as follows:

Union Catalogue are universal, though their number and coverage vary enormously. Union lists of serials are much commoner than monographs. Some UC are published, often in microform.

Direct requesting to libraries for required items is common.

Centralisation may take the form of a UC centre through which requests are directed, or the source of supply may be centralised. Except in the United Kingdom, only limited examples of the latter exist.

Regional organisation is not uncommon, especially in federal countries.

Circulation of requests, among libraries or UC centres, is practised in several countries.

Subject specialisation may be planned as an element in ILL, or exists as a result of CA schemes, or occur by virtue of the existence and nature of particular research institutions.

Hierarchical structure, with requests going through different levels or channels in a prescribed order, appears in some countries.

Most countries have a focus for ILL, usually associated with the national library, but often it is not clear where responsibility for the supervision of ILL lies.

It appears that satisfaction rates often do not exceed 70%, and supply times of 3 weeks or more are norm rather than an exception. Costs seem likely to be generally high. (Line, 1980)

Line and Smith (1980) generalised the following basic points from the existing patterns:

1. Interlibrary lending demand tends to be concentrated on a very limited number of items.
2. Most demand (say 2/3) is in science.
3. Most demand (2/3-3/4) is for journals.
4. The heaviest demand tends to be for common, not rare items.
5. Most demand tends to come from a small number of libraries.
6. A collection dedicated to the purpose of ILL can give a much faster and more efficient service than libraries serving other functions.
7. Distance between libraries is in most countries not an important factor, since most demand comes from those that are situated in cities that are linked by air or fast rail services.

Overall, ILL has advanced greatly in recent years in both developed countries and developing countries, but the situation is far from being perfect. There are wide discrepancies in the services available between countries and even within them. Progress has been helped by the increasing acceptance of the principle of the Universal Availability of Publications (UAP). Briefly, UAP states that there should be the widest possible availability of published material to intending users, wherever and whenever they need it. It applies to all levels, from local to the international and at all stages, from the publication of new material to the retention of last copies. However, practice is still a long way behind precept. (Line & Vickers, 1983)

The following three principal problems have been universally identified:

1. Recognition of the responsibility of borrower and lender;
2. Identification and location of material requested; and
3. Economics of ILL, etc.

Present Situation in Developed Countries

Interlibrary loan systems has evolved in the U.S. over 80-90 years. Recent economic, technical, legal, and institutional changes in the library environment have contributed renewed interest in ILL as a means for satisfying the needs of library patrons for access to documentary sources of information. The American Library Association (1981) summarised the situation:

"Stabilising and declining library budgets have forced libraries to recognise that the concept of "local self-sufficiency" represents an ideal which can no longer be achieved by even the most well supported libraries. The computer, and the development of union catalogues, and on-line interlibrary loan systems have demonstrated that interlibrary loan need not necessarily be a cumbersome process taking weeks or months to complete. Copyright revision has placed new legal conditions on resource-sharing among libraries, and the establishment of state and regional networks of libraries to facilitate resource sharing has done much to change the status of interlibrary loan as a method of document delivery. Recognition of the changing nature of interlibrary loan has encouraged the library community to revise both existing interlibrary loan codes."

The general patterns of ILL in the U.S. has been reviewed by Waldhart (1983) as:

"It is clear that interlibrary loan activity has not increased very much since 1976..." (Boss and McQueen, 1983) would not seem to adequately characterise the rate at which interlibrary loan activities are growing in the U.S. Data from the National Centre for Education Statistics reveal the average annual growth rate for total interlibrary loan request among academic libraries was 7.4%. while that for public libraries was 15.9% ...

In terms of the various types and sizes of libraries participating in the interlibrary loan system, the small and medium sized libraries are increasingly being asked as sources of materials, probably because of the improved accessibility to holding information provided by bibliographic utilities (e.g. OCLC), while special libraries are relying more heavily on commercial document delivery services as a source of materials which previously would have been acquired through the interlibrary loan system. Except for special libraries, most interlibrary loan transactions occur between libraries of the same type. Special libraries, because of their reliance on serial literature, tend to rely heavily on academic libraries as a source for interlibrary loan materials.

Approximately one-half of all interlibrary loan requests are for books, and one-third for serials.

While almost assuredly resource sharing networks have had a profound impact on the nature of interlibrary loan within the U.S., the specific nature of that impact is yet to be determined." (pp209-212)

The formal machinery for ILL between public libraries was set up in the UK in 1916, and by 1930, with the creation of the National Central Library, a national library system was begun and ILL was promoted. However, before World War II, ILL was regarded as an optional extra. Nowadays every library, however large, accepts that it cannot be self-sufficient and it has to rely on other libraries. Usually, some of the largest libraries obtain much from elsewhere. In the late 80's, UK experienced 3 million ILL transaction (Line et al., 1980). The Document Supply Center has been playing a very important and effective role.

Present Situation in Developing Countries, with particular reference to China

It was found by Line and Smith (1980) in a survey of six developing countries that the fundamental problems include a severe shortage of funds for libraries, and a lack of trained librarians, associated with a low status of librarians and a low priority for libraries. Other common difficulties include unsatisfactory photocopying equipment and a shortage of photocopying supplies, poor postal services, inadequate services from book suppliers, lack of foreign currency, the inability or unwillingness of some librarians to co-operate, and complex procedures for ILL.

As we know, access to document requires both that the documents have been acquired and that they can be supplied. It thus involves acquisition programmes and ILL systems. Both of these must be planned if availability is to be adequate. In many developing countries, the problem is not recognised as a serious one, because demand for books is at a low level. There may be several reasons for this. In first place, inadequate local libraries are likely to generate little demand. References to documents are generally picked up from other documents or from abstracting and indexing journals, and if local libraries do not possess reasonable collections of these, few references will be identified.

Secondly, a local library may not be geared to deal with demand for documents it does not have, whether because there is no system for supplying them, or because they are unaware of possible sources of supply, or because the machinery for requesting is inconvenient or clumsy. Thirdly, even if there is an ILL system, its performance may be so poor that it discourages use: delays of several weeks or months, with no great probability of ultimate satisfaction, are likely to deter many would-be users. Finally, the user himself may be require to pay the cost of any loan or photocopy obtained.(Line et al., 1980)

How has been the situation in China? The earliest ILL services in China can be traced back to 1927, which were carried out by the National Library of Peiping (the former name for the National Library of Beijing). During 1930s a number of big university libraries, research libraries and some libraries in governmental organisation began to co-operate, but during the period of 1937-1949, the effects of war resulted in a stop in ILL activities. In 1950s China enter a period of more stable economy. The basis of an ILL system was formed by the establishment in 1957 of the First and Second National Central Libraries and also Regional Central Libraries Committees mentioned above. Unfortunately, the 10 years of the Cultural Revolution caused a setback, and it was not until 1976, with a favourable turn in the economic and political climate, that the ILL service regained its vitality.

The existing patterns of ILL in China can be described as follows:

1. Central supply by the National Library of Beijing(NLB)

   The National Library has established ILL relations with 814 provincial and municipal libraries, college and university libraries, and libraries in scientific research institutes and industrial firms.

   The National Library fills requests in the traditional manner, by loan, photocopy and microform. 90% of requests are handled on the day of receipt, and either the item or

response regarding its supply is dispatched within 10 days.

2. Local Co-operation in ILL

   This type of ILL, too, is based on voluntary co-operation and is carried out in rather a limited number of major cities.

3. Direct Application for Photocopy

   This is already assuming the characteristics of document delivery, This type of supply services is making a contribution for remote users by providing them with photocopies. (Lui, 1984)

As regards China's ILL services, they suffer from almost all the barriers summarised by Line but with an emphasis on severe economic, technical and motivational constraints. There are following aspects needing attentions:

1. Establishing an integrated system;
2. Stimulating the demand for ILL;
3. Promoting bibliographic control;
4. Promoting standardised and unified procedures for requests transaction;
5. Facilitating unified transaction for loan and photocopy requests;
6. Manipulating reference and lending functions;
7. Strengthening the collection of local libraries; and
8. Promoting library user education.

To design an ILL system, it is essential to identify design issues and principles. The following sections will serve this purpose.

8.2.2 Design Issues

Definitions

Interlibrary loan is defined by American Library Association as "a transaction in which library material, or a copy of the material, is made available by one library to another upon request" (1981). And Line et al. (1980) defined interlibrary lending as "the supply by one library to another of documents wanted by individuals"

Both definitions are identical; since the concept of ILL is straightforward.

Document supply is a more deliberate and planned approach. It has been developed as the situation is changing. It is an activity of increasing scale and importance.

Objectives, Policies, Sources of Funds and Governance

Objective

The objective of ILL is noble indeed: to provide the user with access to the world's recorded knowledge. The stated objective entails two aspects:

1. To provide exactly the item that the user needs.
2. To provide the item at the time it is needed.

However, as we shall see, this objective has not been achieved as yet to any notable degree. This is an ideal and user-oriented objectives, for which library and information service will have to strive. From a system's point of view, the ILL services intend to back up the CA programme and other functions, and to improve the system effectiveness.

Policies

Policies for ILL need to be devised with the approval by the participating libraries. They should include the principles about types of resource to be loan, loan period, route of loan, charges and responsibilities etc.

Funds

Beside the funds from the participating libraries and information centres, it is necessary to receive some special funds from the central or regional or local governments to built up the network stocks and to recover the cost of ILL.

Governance

A sub-co-ordinating body under network governance should be established to control the ILL policies in the network and to solve the conflicts among the participating libraries.

Elements of Interlibrary Loan Systems

ILL systems consist of the following main elements (Line et al., 1980):

Collection of documents

Existing holdings of libraries in a region or even a country are rarely adequate for the supply of documents wanted on ILL. They may be supplemented by co-operative acquisition schemes or by a central loan collection or collections.

Means of locating documents

There are three main means of locating documents:

1. By UC

   These are commonest means of access to library holdings. Problems include currency, coverage, difficulty of use, and cost.

2. By directing requests to specialised libraries, or to more general libraries with strong resources in special fields.

   Specialised schemes are likely to be closely connected with national or CA programmes.

3. By directing requests to central loan collections, with more or less comprehensive acquisition of given categories of material.

Procedures for requesting documents and supplying documents

It should be standardised.

Communications

Mechanisms for transmitting requests include mail, road transport, telex, telephone, facsimile transmission and computer.

For transmitting document, mail, road transport, and schemes combining the two are the main alternatives.

The following factors have been identified by Line et al. (1980) as the major factors relevant to the design of ILL:

1. Geography and population
2. Constitution
3. Stage and nature of development
4. Education and research
5. Communication
6. Book production
7. Library resources

Detail can be found in Appendix C.

Structure and Scale of ILL

Line et al. (1980) identified four basic models of national ILL systems, which he described as 1) concentrating on a single library, 2) concentrating on a few libraries, 3) planned decentralisation, and 4) unplanned decentralisation.

The basic models, however, hardly exist in reality by their own alone. Each model need to be supported by other models. Actually, most of existing models are mixed types. For instance, Waldhart argued that while Line suggested that the situation in the U.S. most closely resembled unplanned decentralisation, in actuality the system consists of systems within systems, incorporating all of model types described by Line. At the local, state and regional levels, many ILL systems are carefully planned, structured and co-ordinated. The system may concentrate on a single library, a few libraries or they may rely on planned decentralisation. Therefore, in the practices of planning and design a new system, some reasonable mixed models may be more attractive and feasible.

Methods of ILL

The types of transaction of ILL requests can be categorised into three types, which can be illustrated by the symbolic models (Figure 8.1):

The three types of transactions are: 2-, 3- and N-body.

Considering both type and geographical level, four general classes of two-body transaction can be identified (Duggan, 1969):

(a) Homogeneous vertical, i.e. between two libraries of the same type but at different geographical levels;

(b) Heterogeneous horizontal, i.e. between two different types of libraries at same levels;

(c) Heterogeneous vertical, i.e. between two different types of libraries at different levels; and

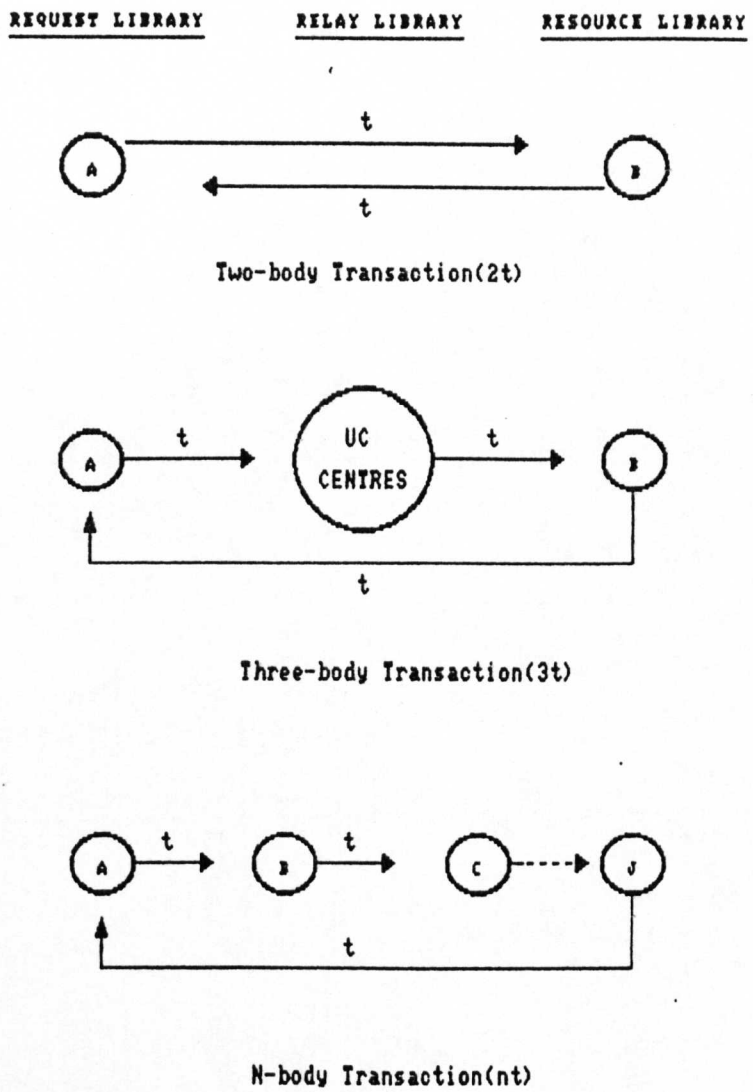
(d) Homogeneous horizontal, i.e. between two libraries of the same type and the same geographic level.

The detailed description of the three types of transaction will be given in a later section. No matter what type of transaction will be, the main tasks of ILL can be identified as follows:

In requesting libraries:

1. Verification — the verification procedure establishes the actual existence of an item and provides a complete and accurate bibliographic description.
2. Finding Locations — this routine takes place simultaneously with verification, but may have to be extended.
3. Transmission of request
4. Conformation of availability
5. Opening packages

Figure 8.1: Types of ILL Transaction



6. Notification of users and lending
7. Returning items, if actual documents borrowed (Martin & Wood, 1982).

In resources libraries:

1. Locating items in libraries' own catalogue
2. Paging and copying (if a photocopy is to be made)
3. Packaging
4. Record keeping
5. Reshelving.

Before the actual models of ILL-UC are proposed, it is necessary to have an overview on UC, in terms of its state-of-the-art, present situation, design issues and principles etc.

8.3 Union Catalogue

8.3.1 Overview

The improvement of satisfaction rates and speed for ILL and document delivery will depend heavily upon the existence of UC and holding lists.

Union catalogue or union lists are to be found extensively in the world, though their number and coverage vary enormously from country to country. There are, for example, over 600 UC in the USSR, while in some countries there are only one or two. It is significantly common that in many countries UC is restricted to the coverage of foreign material. There is usually no such wide coverage of foreign publications, and UC is therefore necessary to identify holding libraries.

Overall, union lists of serials are much more common than UC of monographs. This may be partially explained by two factors. Firstly, in many countries the demand for serials exceeds that for monographs; and secondly, union lists of serials are more easily maintained as they require less frequently updating, and most demand will fall upon titles that are already listed.

Countries in which published UC are to be found include the United States of America, India, China, Australia and the United Kingdom etc.; the availability in published form of regional UC of Federal Republic of Germany is also being considered. Because of their size, many published UC are in microform. Their value for ILL depends upon the currency of information and frequency of publication, and hence the proportion of demand for which they can cater.

UC for particular subjects are to be found in a number of countries. There is marked tendency for these to cover scientific, technical and medical fields.

Computer-held UC exists in the United Kingdom (LASER), the USA (as part of the OCLC system) and the Federal Republic of Germany. Their use is growing, and seems likely that they will supersede other UC systems in some developed countries.

The relative importance of UC in national ILL is difficult to establish. It is known that in the Federal Republic of Germany some 70% of requests are handled by the regional UC and that a sizeable proportion of direct ILL is facilitated by published UC. It also appears that in the United Kingdom UC are used, whether direct by libraries or by regional bureaux and the British Library Division, for less than 22% of ILL.

The purpose and scope of a UC requires as much careful definition as is needed for any other kinds of bibliographic enterprise. In particular it is important to remember that the compilation of a UC requires the willing co-operation of a lot of people—and however willing they may be, they also need to be organised and co-ordinated. While UC of periodicals are more often that not conceived on a national plan, union lists of monographs are usually planned to embrace a group of libraries which are located in one city or relatively small region, or which have similar or related collecting interests.

Librarians in developing countries should be careful to identify the objective and the cost in labour before embarking upon the compilation of union lists.

It is important to see what is feasible within the existing library and financial climate of a given country or region. Over-ambitious schemes and schemes that, even if well designed, have not been accurately costed, are likely to fail: it is far better to establish a modest but efficient UC that can be expanded latter.(Line & Bennett, 1985)

8.3.2 Union Catalogue Systems in China

UC is compiled by the National Library and regional Central Libraries as a by-product of ILL activities. To date these include full-length bibliographies such as the National Union Catalogue of Chinese Periodicals, National Union Catalogue of Periodicals in Western Language, National Union Catalogue of Ancient Chinese Books on Agriculture and the Bulletin of the National Union Catalogue for Book in Western Language Newly Received. There are also bibliographies on specific subjects (e.g. regional industry and agriculture), local literature, works of individual authors, periodicals or bulletins of publications newly received. In 1985, the China authority concerned made a development plan—the design and implementation of the first nation wide Union Catalogue Database System of Chinese S & T Periodicals. It involves almost all the techniques and methods related to the construction of medium-sized Chinese data capture; input methods; data file transfer and Chinese language database design. The project took three years from June 1985 to July 1988, specific objectives of this project include:

1. To develop and test the methodology for producing a Chinese-language Union Catalogue;
2. To gain experience in Chinese character input and output processing and in the interfacing of related equipments; and
3. To integrate the UC operation with ISTIC's general information automation activities.

It is full text online searching system. Some special measures have been taken to solve the problems in Chinese indexing. More than 10,000 titles of Chinese journals held by fifty-six participating information institutions throughout the country have already been stored in the database, which is almost the total amount of Chinese scientific and technical periodicals available. The UC database consists of two parts of information: bibliographic and holding information.

However, among the problems associated with any UC are:

1. Difficulty in keeping up to date (with new acquisition and deletions);
2. Inadequate coverage, especially of all the publication acquired before UC is started;
3. Difficulty of use, particularly when there is a multiplicity of UC; and
4. Cost, both to the co-operating libraries in submitting entries and to the centres in compiling and maintaining the UC.

8.3.3 Design Issues

Definition of Union Catalogue

A UC may be defined as

> "A catalogue based on two or more collections, either in different institutions, or in different libraries in the same institute, provided through the medium of print, microform or computerised data-base. It gives, appended to one bibliographic record for items, the location and summarised holdings data of the respective collections of the participating institution(s). The records may be in one or more orders of arrangement. In accordance with agreed policy, each participant may report the entire records of its collection or may select records, for example, by subject or media." (PGI & UNISIST, 1981, p3)

The decision to establish a UC

The decision to establish a UC will involve in two types of assessments at least, that is the assessment of the circumstance and the assessment of financial and technical resources (PGI & UNISIST).

I. Assessment of the Circumstance

The proposal to establish a UC must first be examined in the light of the special objective of the UC in relation to existing facilities within the library environment. One major question to be considered is whether the objective of the UC could be better served by other means.

II. Assessment of financial and technical resources

The proposal to establish the UC has also to be examined taking into account the effectiveness of existing arrangements of co-operation and careful consideration of the following questions:

1. What is the rationale behind the proposed UC? Are the participating libraries and the users sufficiently clearly defined?
2. To what extent will the existence of a UC result in greater efficiency of access to holdings or in more economic use of library resource?
3. Will there be adequate resources, already existing or proposed, available to compile and maintain the UC on a continuing basis?
4. Will there be sufficient financial and technical commitment on the part of participants to create and maintain UC?

Once the decision to establish a UC has been taken, the following considerations should be borne in mind:

1. Scope and Objectives
2. Resources and Production
3. Development
4. The Management Structure
5. The Participants

Objectives of the Union Catalogue

The objective of the UC is to facilitate access to collections, thereby making the maximum use of resources. In order to facilitate access, the UC provides the necessary information to

1. Identify and locate known items;
2. Record holdings; and
3. Indicate the availability of the items.

In addition to locating known items, some UC are arranged in sequences which reflect specific characteristics (e.g. in a classified order) as an aid to the user in speculative searches. Its significance in assistance can be seen clearly by the stated objectives. A subsidiary function of the UC, consequent upon the cumulation of information in the catalogue, is as an aid to library management.

Elements of UC Systems

The design of UC system usually involves two major issues, i.e. compilation (including production) and maintenance (including location of UC services).

I. Compilation and Production

In compilation and production, the following should be taken into account:

1. Selection of Contributing Libraries
2. Types of Union Catalogue
3. Form of Entry
4. Organisation
5. Content of Bibliographic Records and Compilation

Now the author focuses on the organisation in compilation. The other issues can be seen in Appendix D.

Organisation in UC compilation is essential: it may involve some first stage organisational preparations and then organisation in Editorial Centre (processing centre).

1. First Stages

   Before operational work on the compiling of a UC can begin:

   - The objective of the UC should have been established;
   - The commitment of the participating libraries to these objective should have been obtained;
   - The editorial centre should have been established, with staff including a project director; and
   - Existing resources should have been utilised.

2. Editorial Centre (processing centre)

   As for the editorial centre, three major decision, i.e. location, staff and function, should be made.

   Location: The editorial centre may be situated as an office or department in one of the participant libraries or it may be separate from them. It is important in considering its location to recognise that to operate effectively the staff of the centre will need to have easy access to a wide range of bibliographic and reference tools.

   Staff: The staff appointed to the editorial centre will usually be librarians with experience of cataloguing and the tools of bibliographic control. Then head of the editorial centre will co-ordinate the decision-making procedure and will be responsible for interpreting policy decision.

   Functions: The editorial centre controls and maintains the bibliographic content of the UC according to the agreed objectives and available resources. It liaises with the participating libraries. It ensures compatibility and consistency of the catalogue with those standards to which the organisation, of which the editorial centre forms a part, may have committed itself.

While the compilation usually takes the following three basic methods:

1. Participating libraries submit existing records which are then edited and cumulated at the editorial centre. This method permits participants to copy their records in whatever form is most convenient to them, but increases the editorial centre's workload.

2. The use of existing databases from which the editorial centre's can extract ready-made records. The first method above can be used in conjunction with this method, and as the UC itself grows, so it will possible to match new notifications against existing records. This method lends itself to maximum reporting on the part of participating libraries.

3. Participating libraries submit records created especially for the UC. This method allows the greatest degree of editorial control and consistency, but the work load falls principally upon the participating libraries.

Detailed arrangement of the UC can be seen in Appendix D.

II. Maintenance and Location of UC

Maintenance

The UC best serves its purpose as a location tool when it is kept up-to-date with special attention paid to the inclusion of new titles. The participating libraries and editorial centre should commit themselves to providing complete and accurate inventories reflecting new, changed and deleted records.

It should be remembered, however, that up-dating a file is a labour intensive process, the scheduling of which should be included in preliminary planning. Machine readable systems facilitate up-dating. Microfiche is a relatively economical support for frequently up-dated editions. Online systems enable data to be up-dated and made available immediately to those with access to the database.

Where manual methods are used, techniques should be avoided which add to the difficulty of up-dating. Frequency of printed issues will depend upon the size of the UC, and the professional, technical and financial resource available to prepare the records and edit the input.

Location of Union Catalogue

If a country or region or a network opts for a system of separate UC these may be housed in several different libraries. Distributed location raises questions of finance for the libraries concerned, of the incentive for them to continue the UC committed to their charge, and of overall control and compatibility. If there is to be a single national or regional or network UC then the ideal location is in the national or regional or network ILL centre if one exists. This may be the national or regional library or strongest library in a network, or, albeit unlikely in a developing country, a dedicated national or regional ILL centre. One advantage of housing the UC in the national or regional library or a special national or regional centre is the existence of a collection upon which the UC can be based, provided this stock can be lent; there is also some assurance of continuity and possibly of government involvement. Locating UC in a national or regional centre also makes for better control and management; a national or regional centre is in a position to co-ordinate ILL system and to incorporate the UC or catalogues into national or regional ILL system. Wherever UC is housed it must be staffed with suitably qualified personnel, and a range of bibliographies must be available for verifying requests.

The location of UC in a single centre facilitates the collection of performance statistics, which will serve as a measure of the success or failure of the catalogues. Data collected can help to determine whether the UC has the right balance of contributing libraries, and it can also highlight areas of inadequate provision and so aid the development of a co-ordinated national or regional policy.

Technologies have brought out various impacts on ILL-UC systems. Thus it is sensible to identify the possible impacts and compare the alternative programmes, in terms of cost-effectiveness.

8.4 Impacts of Technology on ILL and UC Systems

This is a time of rapid technological change. Some of this will undoubtedly affect ILL and UC and should therefore be taken into account in the design of ILL and UC system.

Line et al. (1880) has discussed the following main technological changes likely to affect ILL:

Possible changes in the pattern and form of publication

These include publication in microform, publication in summary form (e.g. synopsis journals), high density storage such as holographs, bubble memories and crystals, and the on-line "electronic journal".

There is no doubt that various alternatives to the conventional printed paper will continue to be explored, and that some at least will prove viable for certain kinds of material. However, it seems doubtful if, from the viewpoint both of economics and of acceptability, conventional publication will be superseded for material for which there is a substantial market. Line et al. (1980) concluded that such changes in the pattern of publication as can be clearly envisaged at present need not be taken into great account in designing ILL systems, but that such effects as they are likely to have may tend to favour central loan collection.

Changes in locating, requesting and supplying documents

The main technological developments are facsimile transmission, television technology, other forms of document transmission (e.g. satellite), and computer technology.

The greatest impact on ILL is likely to be that of computer technology. It can, as we have seen affect the form in which documents are held. It can also be used to construct and maintain UC, and to publish them, in hard copy or more usually on Computer Output Microform (COM). Computer-held UC can also be accessed on-line, and this facility may also aid CA policies, thus affecting document provision. The bibliographic checking of requests against authoritative files is possible. Finally, requests for documents can be made on-line.

For instance, the automation of union list has had great impact on ILL particularly in the United States, where OCLC can be said to have transformed the situation. Automated union list with on-line access and the ability to switch requests greatly improves the identification of locations, the speed of requesting and of response in the case of delay or non-supply.

Whether the use of computers will significantly affect the balance between central loan collections and co-operative programme depends on several factors. First, appropriate computer systems must be developed; this is easier to achieve in developed countries than in developing countries. Secondly, effective on-line systems require that at least the majority user of libraries have appropriate terminal facilities. Thirdly, even in developed countries, computer systems can provide access to only a limited though increasing proportion of the documents required unless existing UC are automated or co-operating libraries submit entries in machine-readable form for existing holdings; Catalogue conversion on this scale is a huge undertaking. Fourthly, fast access to locations, and the speed of requesting offered by on-line request systems, do not in themselves make the document available; libraries are often unable or unwilling to supply many of the documents for which they are requested on ILL, because they are in use locally. Finally, and perhaps most critically, documents have to be acquired before they can be supplied: computer access can assist document supply, but can hardly extend document provision unless the system is also used for CA.

Based on the above review of the existing situation of ILL and UC services both in advanced countries and in China, and the diagnosis of possible technological impacts and the reflection

of the design principles, it may be possible to come to a decision about what kind of model a China's Agricultural ILL-UC system should adopt. The following sections attempt to meet this end.

8.5 Models of China's Agricultural ILL-UC Systems—Descriptive

When one proposes and designs a model for an ILL system and UC system in China, it should be kept in mind that China is one of the more advanced developing countries, with enormous development potential in the economic, educational, and scientific and technical areas. In addition to that, its vastness of area, its distribution of populations, communications and transportation, the system of its library and information services must be taken into account.

8.5.1 National and Regional Agricultural ILL-UC systems as Back-ups for Local Networks

The proposed model for a national agricultural ILL system—a subsystem of national ILL systems in China, might be described as a combined pattern with a national centre in co-operation with planned/decentralised/regional systems; planned/composite/decentralised systems with hierarchical /local/ILL systems.

1. The national centre for the (agricultural) ILL system—STDIC-CAAS would naturally become the suitable candidate. The centre will be supplemented by a few national library and information services, such as the National Library of Beijing, the ISTIC, the National Patents Bureau etc.
2. Planned, decentralised (agricultural) ILL systems at regional levels—the six major regions in the country would have their planned, decentralised, agricultural ILL systems with co-ordinating centres within the regions. The lending units of the regional systems would be provincial centres for agricultural libraries or information agencies.
3. Planned/local/composite/hierarchical systems in co-ordination with decentralised system—provincial agricultural libraries or information centres of five sectors would be the first-level centre of their respective sectors (hierarchical), and the co-ordinating centres with other sectors (decentralised), which will be discussed in detail later.

To set up a national (Agricultural) Interlibrary loan system, the following aspects need attentions:

1. A national co-ordinating centre dedicated for ILL, under STDIC-CAAS, should be set up. It, together with regional and local co-ordinating centres should be responsible for drawing the policies, regulations and standards for ILL, co-ordinating between related institutions, and monitoring the performance of the system.

2. The resources and services at local libraries should be promoted.
3. Union catalogues are necessary at regional and local levels. The use of the UC in the format of microform and MARC should be facilitated.
4. A unified ILL request form has to be designed. The routine procedures should be as simple as possible.
5. The photocopying facilities have to be improved.
6. Routine statistics for ILL have to be gathered in order to monitor the performance of the system.
7. The postal expenses for ILL should be waived for individual users.
8. Training courses or seminar concerned with this area should be regularly held for the administrators and librarians from the institutions of interest.

The top-bottom infrastructure mentioned above is viewed from the national level's points of view. More interesting to the author is a bottom-top planning approach for a local network. The latter is more local user-oriented.

As the author proposed above, under a unified CA programme, the network would be assured of acquiring the largest possible stock, with minimum unnecessary duplication. In such a case, majority of the requests unfulfilled by the local libraries should be able to be satisfied somewhere within the network. As for the route policies of ILL, the requests should be sent to 1) a UC centre first, if UC is available; 2) specialist libraries of the speciality; and 3) libraries of similar types or in the same geographical area. This issue will be discussed in more detail under the next heading.

According to considerations of cost-effectiveness, and also because of budget constraints, some less popular or expensive items are left out in the acquisition policies. Requests may arise for such items. But we still can assume that only a small proportion are unable to be satisfied by the local network. The reasons are obvious; apart from the one mentioned above, i.e. large possible coverage guaranteed by CAP, another reason is the geographical specialities in agricultural production. We may drew the conclusion that a small proportion of requests falls into the following categories: 1) less-used, or expensive items; 2) high-level and theoretical, or marginal disciplinary materials; and 3) items on less popular specialties in the local agricultural research and production etc.

Those requests will be relayed to the respective regional co-ordinating centre by a provincial centre of respective sector. If UC is available in the centre, a request can be located and sent to a resource library in the region. But if there is no UC in the centre and a request fails to be satisfied there, it will be relayed to the national centre. In principle, the route of a request is hierarchical since the specialties are more alike within a region and the higher level a library is, the bigger stock it has. In practice, especially if a regional or national UC is available at a regional level, it is more efficient if a request is located there and sent to the resource library, no matter where the library is. If more than one resource libraries are located, the request should be sent to the one within the region or the nearer one.

The reasons for having a regional co-ordinating centre can be seen from the following:

1. As a first back-up to meet the demands on subject information—since the agricultural production in China shows strong geographical specialties, the province in the same regions are faced with similar problems in agricultural research, education, production and marketing. Thus the stocks of the libraries in the same region have their common subject characteristics to reflect their problems.

2. As a first back-up to reduce the workload placed upon the national centre—imagine how big a workload it would be to satisfy all the requests from 29 provincial networks, each of which consists of around thirty main libraries and information centres.

3. As immediate access to reduce the turn-around time and costs for postage—the distance between request and resource libraries in such a vast territory as China do affect the turn-around time if rail transportation is used as a main means of mail. The national centre is almost situated in the north-eastern corner of the country. Apart from a couple of neighbouring provinces, most provinces are further away from the national centre than from the respective regional co-ordinating centre. The possible delays in mailing if requests are directly relayed to the national centre, vary from 2 days to more than a week, which depends on the distance and frequency of the train services. As for the costs for postage, there is no significant difference for an ordinary letter. But it does make some difference for a parcel. The costs increase as the distance increase.

4. As a planned focus to avoid unexpected traffic through other channels (other regions)—an effective way is by sending the requests to the respective regional centre first then relaying them though a planned channel.

To sum up here, the proposed ILL infrastructure for a local network and its two upper-level back-ups has taken the following into account:

1. The existing patterns;

2. Design Principles; and

3. Cost-effectiveness.

The importance of having regional back-ups can be seen from their roles. The removal of such back-ups will lose the benefits and effectiveness already explored.

Now we need to examine the importance of UC in facilitating ILL transaction. It is clear that in a structure on such a large scale, UC at certain levels is essential. Otherwise, N-body transactions in such a big territory is unimaginable. At local level, a union list of networks is desirable. Keeping regional or even national union lists for agricultural sciences in the network is possible if these are in the form of printed copy or microform. If a request can be located locally, the hierarchical route is the principal rule, but an exception may be if the resource library happens to be in a neighbouring province. In other words, transaction

between the nodes at the same level should be permitted in order to improve the efficiency of transaction.

MARC UC for books and monographs is in the plan for the national centre. It should be available at least at a regional centre to make use of the computer facilities already available there. Therefore, a regional UC centre will play an important role in ILL transaction region-wide.

The above discussions were mainly devoted to the ILL outside the local network systems. A careful design for the ILL-UC system inside the local network is more important in this thesis. Again ZALINET is taken as an example of a local network and the following description is dedicated to its ILL-UC system.

8.5.2 Description of ILL-UC system In ZALINET

ILL-UC services are regarded as two of the most important network functions in ZALINET. The objectives, structures, governance etc. should be identified according to its own circumstance. The performance of the function has a profound effect on the overall network and other functions. As the author has emphasised, the design of individual function should take consideration of the relationship between the function concerned and other functions. Therefore, when designing ILL system for ZALINET, we must make sure whether it will fit the network and whether the relationships with other functions, such as CA and UC are understood and used.

The specification for the ILL-UC system in ZALINET can be described as follows:

Objectives

The ILL-UC system in ZALINET intends to develop an effective system capable of

1. Achieving maximum user satisfaction, with minimum delays and costs;
2. Interconnecting with other ILL systems for unfulfilled requests;
3. Supporting the execution of CA programmes.
4. Locating the ILL requests efficiently and facilitating ILL transactions.

Co-ordinated Body

A sub-committee dedicated for ILL should be set up. The provincial-level centres of each sectors will be the members of an executive body. The executive body will play the roles of co-ordinating, supervising, controlling, policy-making and fund-getting etc. in the ILL-UC system.

Funding

The ILL-UC system will be funded mainly by participating libraries. But special funds should be obtained from every level of government to recover the costs of ILL and to support the production of the UC. No fee should be charged to individual users.

Standardisation

Standardisation in the request form, UC and evaluation methods should be facilitated.

Structure

The structure of ILL in ZALINET will be planned/decentralised between sectors and hierarchical within sector in terms of management. Within one sector, the hierarchical structure of ILL can be described in three levels 1) county level, 2) prefectural level, and 3) provincial level. Among the sectors, the respective provincial level centres will serve as co-ordinating centres and communicate with each other. The executive body will consist of those co-ordinating centres and thus control and administer the ILL system.

As for information flow, or transaction in ILL system, more channels, and immediate access should be created to speed up the transaction. Three routes of transaction have been identified and proposed as principal routes. They are *homogeneous horizontal*, i.e. transaction between libraries of same type and same geographical level, *homogeneous vertical*, i.e. transaction between two libraries of the same types but at different geographic levels, and *heterogeneous horizontal* type of transaction, i.e. transaction between different types of libraries at same geographic level. The particular route chosen should take consideration of distance, subject and nature of the request and cost etc. As far as the first two routes are concerned, the same type of libraries are most likely to hold the stock of similar subjects and nature, and it will save some bureaucracy since both of these are in the same hierarchy. While concerning the third route, requests circulated within the same geographic areas will speed up turn-around time. Therefore, an effective ILL should allow communication across levels, types and hierarchies.

The structure of UC processing, however, should be more centralised. Based on the stocks of the centres in the respective sectors, some supplementing could be done through the stock of specialised institutes and lower-level libraries. Records of the stock should be submitted to the editorial centre for compilation and production. Union lists of both Chinese and foreign periodicals and a UC of foreign publications are priorities to be produced. The determination of the forms of the UC should be based on a cost-effective consideration and existing economical and technological conditions at the time of planning.

The number of sites for UC services depends on 1) the size of UC; 2) the varieties of UC; 3) the costs of multiple copies and 4) the availability of staff for UC consulting etc. This issue will be discussed later.

8.5.3 Identification of Components in three Programmes Compared

The introduction of computers into library operations and the development of new technologies have facilitated the development of an ILL-UC system and their introduction have been responsible for a large increase in ILL traffic.

The creation of an online UC greatly extends a library's bibliographical capacity. Whereas manually-created UC are very selective, online catalogues can include whole range of materials which are not usually included in regional catalogues. Such information is of use to all departments of the library and, indeed, online systems are breaking down the barriers between library functions.

The impact of new technologies is obvious but automation can never be cheap. Looking at the present situation in China, we can not expect a great degree of computerisation in the ILL and UC systems. Therefore, a feasible system can only be worked out by a cost-effective-benefit comparison. Complying with the overall philosophy of design, the three alternatives to be compared are the Manual ILL-UC System, the Semi-computerised ILL-UC System, and the Computerised ILL-UC System.

Manual ILL-UC System

By a manual ILL-UC system, the author means that the traditional way of transaction will be adopted. That is, mail will be the main means both of transmitting requests and documents. The pattern of publication transmitted are mainly original printed version, photocopies and some audio-visual tapes. The location information, i.e. the UC will be in printed form or microform.

Semi-computerised ILL-UC System

By a semi-computerised ILL-UC system, the author means that computer will be partially involved in the system. The centres of each sector will be equipped with computers, microform cameras, readers, telex and Telefacsimile etc. The UC will be available in MARC form in the centre computers for locating requests and producing COM (Computer Output Microform). COM will be distributed to prefectural centres or even widespread. Computer can also be used, in a batch mode, to dispatch requests by printing requests on to request forms. Transmission of request will rely on mail, or telephone or telex. On the other hand, the means of document transmission will be mainly mail or Telefacsimile, if an urgent request is raised.

Computerised ILL-UC System

By computerised ILL-UC system, the author means that an ILL system will be equipped with minicomputers or microcomputers to process UC, while local libraries will be equipped with terminals to link with the centres. That is to say a online UC system will be implemented. In such a system, requests can be transmitted by electronic mail. While the means of transmitting documents can be mail, telefacsimile and electronic form.

The means of processing and resources, equipment and facilities involved in the respective three programmes can be summarised in Table 8.1.

The same fashion is taken, i.e. the descriptive models, followed by mathematical models.

8.6 Model of ILL & UC System—Mathematical Model

As with the usefulness of the mathematical model in CA programme, the mathematical model here will provide trade-offs between 1) cost and effectiveness (benefits); 2) objectives of overall system and individual functions; and 3) objectives of network and individual nodes etc.

The models formulated is to fit a local network environment.

8.6.1 Defining Performance Criteria

"Performance" in ILL is the success of a system in meeting demands and needs for documents. It is therefore vital to know both what *demands* there are for documents and also what *needs* there are, and to know too how quickly they are wanted. It is then possible to judge performance against these requirements. For this purpose, the main performance measure can be identified as *fill rate* (the proportion of requests fulfilled), *user satisfaction rate* (the proportion of users' needs met), and *speed* (turn-around time). However, these performance measure, while of major importance, are incomplete without costs (though costs are not strictly a measure of performance). The cost of ILL covers all costs, including the cost of constructing and maintaining the UC and the hidden staff costs in requesting and supplying libraries, as well as the costs of stationery, postage and possible book purchase. Ultimately what any system should achieve is *maximum cost-effectiveness.* (PGI-UNESCO, 1983)

However, no performance measures, whether used in isolation or together, can give a complete picture, if only because it is never possible to apply them comprehensively and exactly. Most measures are relative, since there can be no absolute objective standard.

Line (1981) draws attention to some aspects on ILL which are sometimes misconceived. They are that:

- Distance is almost irrelevant to the speed of supply. Distance does however affect the cost of transmission. *(But, it is not true sometimes for a vast territory with poor transportation services—the author's comment)
- Most of the delays in interlibrary lending occur not in transit but in requesting and supplying libraries.
- A high proportion of demand is for a rather limited range of items that are held by several or many libraries and that receive heavy use locally.

Table 8.1: Comparison among Three Programmes (ILL-UC)

(Interlibrary loan&Union Catalogue)

Fuctions / Processing	Program One (Non-Computerised)	Program Two (Semi-Computerised)	Program Three (Computerised)
ILL			
MEANS OF PROCESSING:			
Verification & Location	Manual	Manual/In-house COM Database	In-house Database/ On-line Catalogue
Transmission	Mail/telephone	Mail/Phone/Telex	Electronic Mail
Document Supply	Mail	Mail/Fax	Mail/Fax/Electronic
Reproduction	Photocopy-Mail	Photocopy-Mail	Photocopy-Mail
			Electronic Full-text
RESOURCE, EQUIPMENTT & FACILITIES INCURRED	Staff time	Staff time	Staff time
	Telephone Photocopiers Stationary	Telephone,Telex,Fax Computers(centres) Photocopier,Stationary Micrographies	Computers+terminals Telecoms,Fax Machines Photocopiers,Stationary
UC			
MEANS OF PROCESSING:			
Cataloguing	Manual(Cards/Book)	Manual-Microfiche	MARC-Inputing
Compilation	Manual	Manual/Computer (Centre)	Computer
Production	Card/Print	Book/COM	On-line MARC/COM
RESOURCES, EQUIPMENT & FACILITIES INCURRED	Staff time	Staff time	Staff time
	Cards & Paper Print Facilities	Centre Computers Micrographies	Computers+terminals Tapes & Discs Software Packages Telecoms

- Interlending is not very cheap and it is certainly never free. However maintenance of UC is expensive and it is impossible to make it comprehensive. Reduction in the effectiveness of UC, results in the requests circulating to three or four libraries before they can be fulfilled—another cause of delay in the ILL process.
- A fundamental cause of delays is that the first responsibility of a library is to its own clients, not to those of other libraries; systems are geared to local service not to ILL.

8.6.2 Presenting Problems & Modelling

Turn-around Time

In an ILL system, obviously the use of the UC is of assistance. But it is also obvious that the UC is expensive to produce and to keep, and that it is almost impossible for all items to be included in UC. Therefore, a careful cost-effective consideration about whether the UC is to produce or not and whether it will be kept centrally or locally should be taken.

Based on the above analysis, we can, therefore, assume the following three possibilities of UC availability:

1. UC locally accessible (i.e. each node keeps a copy of UC);
2. UC centrally accessible (i.e. only central node keep UC);
3. Non-UC available in the network.

Therefore, they can be categorised into three types of transaction according to the characteristics of the transactions, which has been mentioned earlier.

These three cases has been illustrated earlier (Fig.8.1).

Two-body transaction

As mentioned earlier, this type of transaction usually happens when the request library has a UC and it sends the request directly to the resource library located. The author here assumes that if the title required is not available at the moment of a request's arrival, the request will wait instead of being relayed. We also assume, that, network-wide, this type of transaction happens between all nodes only under the condition that every node has a copy of UC to locate the request.

Three-body Transaction

Again, as mentioned earlier, this type of transaction usually happens when the request library has no UC to locate the request and it has to send the request to UC centre, where the request can be located and relayed to the resource library. That means that there is at least one UC centre available in the network-wide. But the high probability of three-body transactions in

the whole network happen only when UC centre are less than J/2 (J is the number of nodes). The time taken for turn-around, i.e. initialising a request, relaying the request and delivering the document required is

$$T = T_i + T_r + T_d.$$

If we assume that there is not much difference in mailing time between any two of the nodes, and that the relay library with UC acts as a switch board (the probability of it satisfying the requests will be ignored), then the time associated with distance in a three-body transaction will be 3t.

N-body transaction

This type of transaction usually happens when there is no UC available in the network-wide, so the request library send the request to a library without knowing if the title is accessible in that library before-hand. If it fails to be satisfied, the request then has to be relayed to the second or the further one until it is satisfied. In this case, the transaction can be two, or three, or more bodies involved. The more copies of one particular title requested the network holds, the less bodies will be involved in the transaction of this particular request.

The detailed procedures of ILL transaction in these three cases can be illustrated in flowcharts (Figure 8.2 & Figure 8.3).

The total turn-around time in three cases can also be illustrated in maps (Figure 8.4).

Speed is important not only as a comparative measure of performance but because its measurement can identify weaknesses, in particular the precise points where delays are occurring, and lead to steps towards improvement, whether by changing the system so that some procedures are eliminated or simplified, or by making the operation of the procedure more efficient.

It is obvious that to reduce the total turn-around time, we have to 1) reduce the processing time in either request library, or relay library or resource library, 2) reduce the waiting time in the queue, and 3) speed the transmitting time, relay time and delivery time.

Concerning the processing time, it is related to the number of staff allocated to processing, the experience of staff, professional levels of staff and processing procedures etc. Taking on more staff in ILL transactions also means increase of cost per request processed. A trade-off happens here between efficiency of ILL transaction and cost.

As regards the waiting time in the queue when the request arrives at the resource library, it can be reduced by increasing the number of copies of high demanding titles. Again there is trade-off between the user satisfaction (availability) and cost.

As far as the time for transmitting a request, relaying a request and delivery are concerned, it is very much dependent upon the means of transmission. Usually, the postal system in a given country or area would be outside the control of either requesting, relaying or resource libraries, if mail has been decided as the means of transmission. One possibility is to design reasonable route policies. But there may be other alternatives chosen to speed the transmission, such as fax, electronic network etc. Again, there occurs a trade-off between speed and costs.

Figure 8.2: Flow of ILL Transaction (with UC)

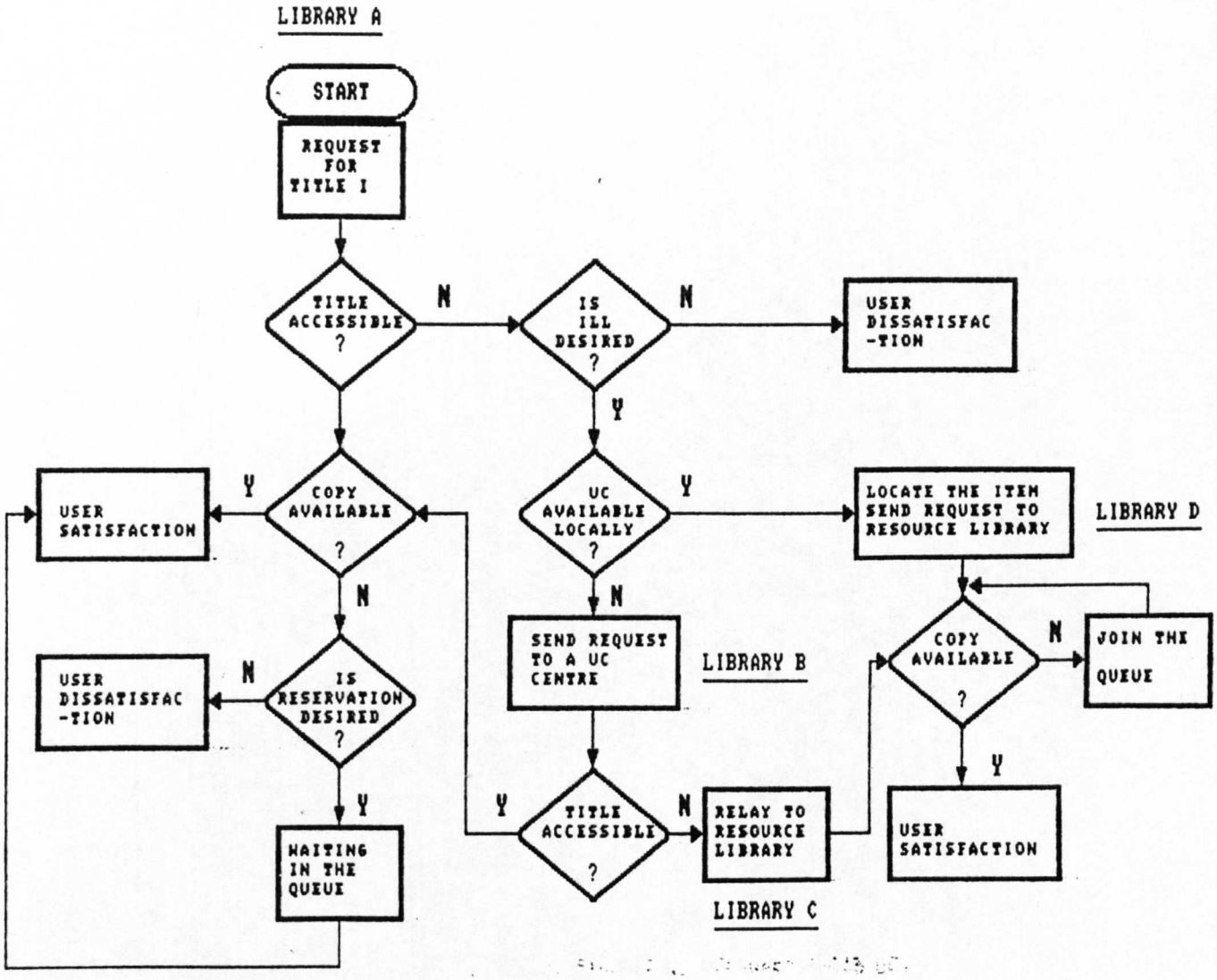


Figure 8.3: Flow of ILL Transaction (without UC)

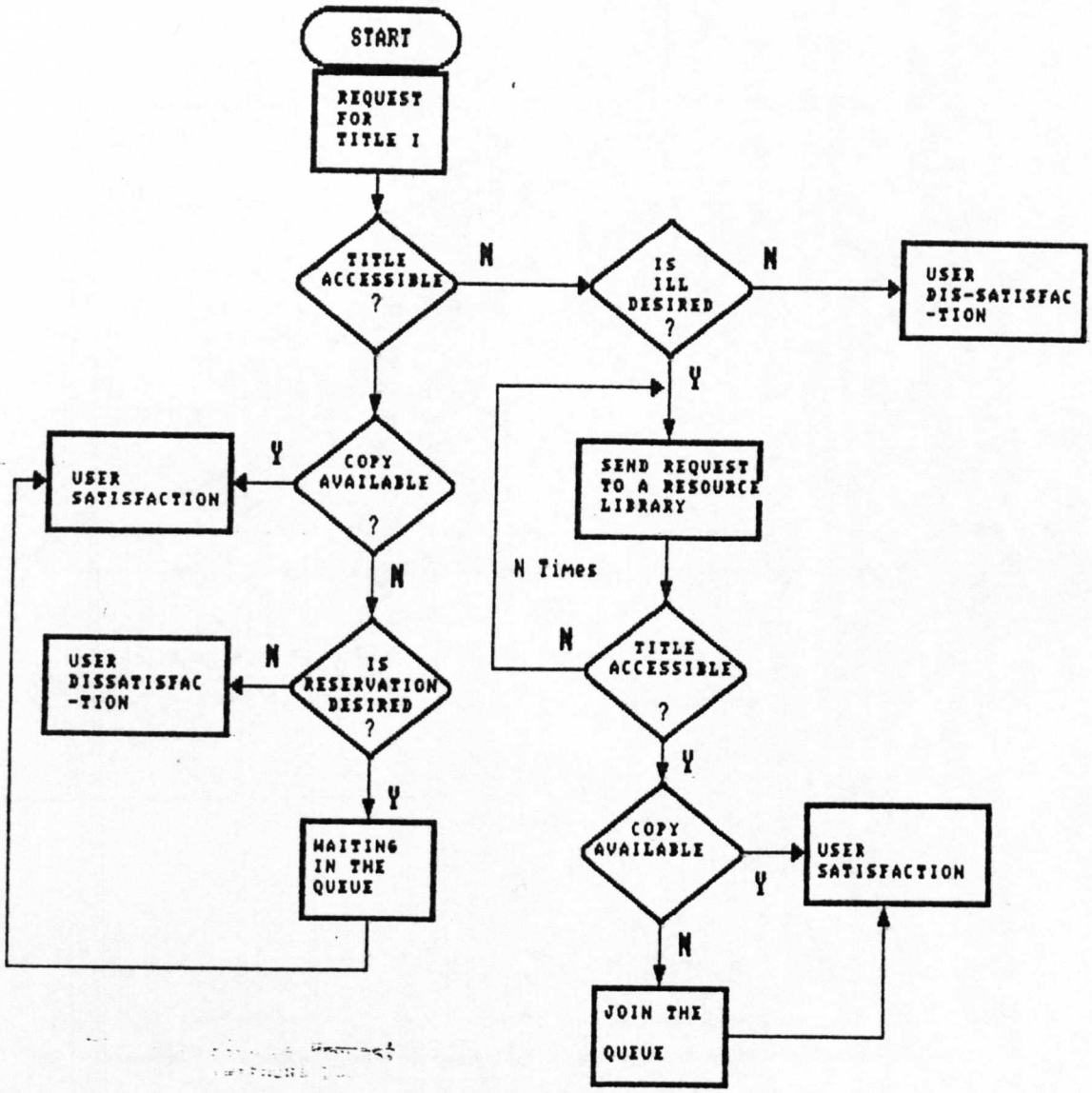
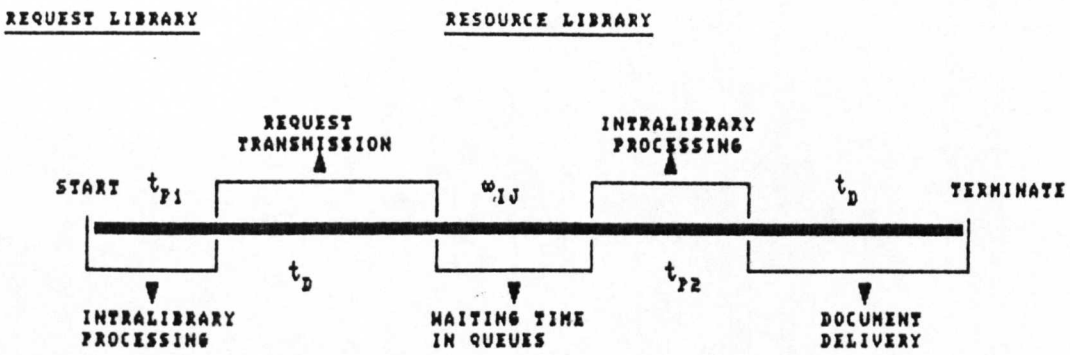
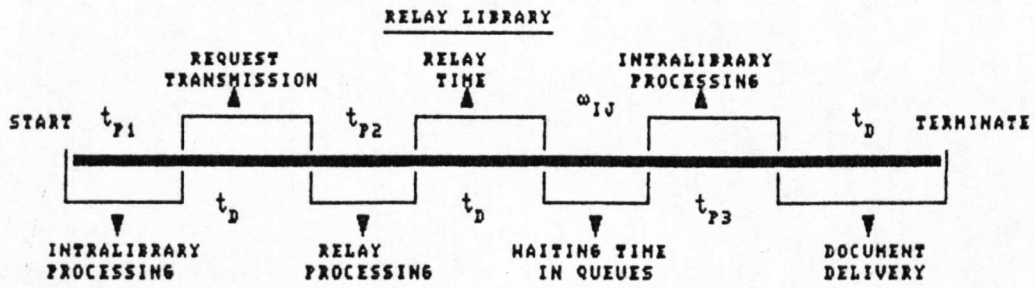


Figure 8.4: Graphic Models of Turn-around Time



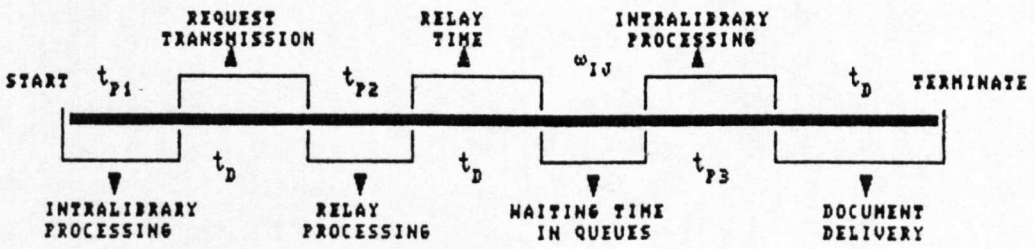
Total Turn-around Time(Two-body Transaction)

$$T = t_{P1} + 2t_D + \omega_{IJ} + t_{P2}$$



Total Turn-around Time(Three-body Transaction)

$$T = t_{P1} + 3t_D + \omega_{IJ} + t_{P2} + t_{P3}$$



N times

Total Turn-around Time(N-body Transaction)

$$T = t_{P1} + nt_D + \omega_{IJ} + (n-2)t_{P2} + t_{P3}$$

Moreover the accessibility and availability of a UC network-wide affect the speed of turn-around time. In three cases mentioned above, the first case, i.e. a UC locally available leading to a Two-body transaction would certainly be time-saving but higher costed since the local maintenance of a UC is costly. Therefore, the trade-off, in this context, would be between the accessibility, availability of UC, eventually speed of transaction and cost of UC.

In the light of the above problems for trade-offs, some objective devices are required.

Based on the model for the turn-around time (illustrated earlier), the time difference between each different types of transaction can be identified: the more bodies involved, the longer the turn-around time. To reduce the turn-around time, at least one of the following measures should be taken:

1. Increase the staff time for ILL handling and improve the handling efficiency;
2. Increase the duplicated copies of a particular title, which has a profound effect on N-body transaction. Nevertheless, under a unified and optimal (assuming) CAP, the duplicated number of copies are certain;
3. Introduce a UC service, which will greatly facilitate the ILL transaction.

Thus trade-offs can be made between 1) speed, satisfaction rate and costs, 2) ILL function and UC functions and CA functions, 3) Overall network costs and individual functions costs etc.

Cost-effectiveness of UC Availability

Taking an overall view, a UC has a time-saving effect on ILL in the network. But the production and implementation of the services cost money, staff and space especially if a printed one is produced and maintained. Therefore, the decision whether the network will produce a UC for ILL should be based on the cost-effective analysis.

Once the network decides to compile a UC, it is necessary take into consideration of cost-effective issues about 1) form, 2) variety, 3) coverage, and 4) degree of availability of UC services.

The determination of the first three issues should be based on a cost-effective-benefit comparison in Chapter Ten. While the optimum number of UC centres and their location can be determined by a trade-off between the effectiveness and costs. The author applies a goal programming technique to formulating a model in order to solve the problem concerned (Appendix D).

The underlying philosophy implies that the nodes with high arrival rate, high handling efficiency, easy accessibility and cheap staff costs will have the priority for keeping a UC and carrying out a services for UC consulting.

Chapter 9

The Design of IR System

9.1 Introduction

9.1.1 History of Methods for IR Systems

In the western countries, the history of methods for the physical implementation of IR systems falls into several periods:

1. Pre-1940: Pre-coordinate indexes, completely manual, in printed book or card form.
2. 1940s: The first post-coordinate indexes; manual.
3. 1950s: Punched card systems; microfilm retrieval systems.
4. 1960s: Computer-based systems operating via magnetic tape in an off-line batch processing mode; improved microfilm systems.
5. 1970s: Computer-based systems operating on-line.
6. 1990s: Completely paperless systems (?)

The list indicates only the decade in which the major development in a particular type of system occurred. The first computer-based systems were introduced in 1950s, but off-line batch processing systems only began to have a significant impact on information services in the 1960s. Experiment with online retrieval dates back at least to 1964, but on-line systems really only came into their own in the 1970s. The developments of the 1990s, of course, are purely speculative. (Lancaster, 1979)

9.1.2 The Development of Computer-based IR Systems

Initially, computers were employed to produce printed abstracting and indexing services more efficiently. As a by-product of the generation of the machine-readable databases necessary for the production of the printed indexes, the machines were used to process both current-awareness and retrospective literature searches in batch mode; i.e. a number of searches or user-profiles were run at one time "off-line" at an information centre to which the user addressed his request for information. Now remote terminals are used by librarians, information scientists ("intermediaries") acting on behalf of their users and, increasingly, by the end-users (i.e. those who will ultimately use the information from the search) themselves, to interact conversationally with the machine-readable databases in on-line searching. The IR industry is now expanding rapidly and its structure is still evolving. The electronic database, with no corresponding hard copy version, has now emerged and as the costs of paper and print escalate and the cost of online access to databases over telecommunication networks diminishes, the continuing existence of hard copy abstracting, indexing, and in many cases referral publications, is uncertain.

The computer was first publicly applied to the processing of bibliographical information in 1961, when the Chemical Abstracts Service (CAS) produced Chemical Titles (CT), a machine-generated alphabetical subject index to the 600 most influential journals covered by the parent journal Chemical Abstracts. By the end of 1960s a whole range of new CAS publications had been produced from a machine-readable database. In this system the abstracting and indexing information was culled from the source journals in a single process of intellectual analysis before it was input onto the database in a single keyboarding operation. Computerisation was steadily adopted by other services, and by 1970 the first phase of the computer revolution was completed. The new processing methods gave the secondary services (i.e. indexing and abstracting services) the increased flexibility necessary to adapt to the changing patterns of research. The result of this first phase of the revolution was greatly improved secondary publications; they were more up to date, more comprehensive in their coverage of the literature, and they were equipped with better indexes which cumulated more frequently. In addition, users were given the facility of running "profiles" against the database to keep them informed of recent papers covering their spheres of interest, and they could also search the database retrospectively to retrieve all papers which satisfied a search strategy designed to circumscribe their subject demands.

On-line IR Systems

The general availability of online access to bibliographical and non-bibliographical databases is the inevitable technological consequence of applying computers to the processing of bibliographical and referral information. The computer revolution has progressed rapidly and its successive stages are now clearly discernible.

Interactive online retrieval systems, which enabled the user to communicate directly (in a conversational mode) with the database being searched were being developed by the System Development Corporation (SDC) as long ago as 1965. After a developmental period which

extended into the early seventies, the use of online bibliographical systems became widespread in the United States and more recently in Europe. MEDLINE (Medical Analysis and Retrieval System ON-line) was one of the first online bibliographic databases to be developed and made generally available, and subsequently it has become one of the most heavily used of the wide range of databases which can now be accessed online.

According to the estimation by "EUSIDIC Data Base Guide", by 1982, the total number of commercial databases has reached 1845 in the world, of which bibliographic, numerical and factual databases are 762 and 1083 respectively. The latter occupies a higher proportion. For the time being, the development of databases has shown the following characteristics: 1) industrialisation of processing and production, and 2) multiplicity of functions. The online IR industry has three clearly identifiable sectors:

1. The producers of the databases;
2. The service suppliers or vendors, sometimes referred to as "spinners"
3. The users of the systems; libraries, information services, information brokers, and the end-users themselves.

The producers of bibliographical databases are typically the learned societies and institutions, which have traditionally undertaken the responsibility of organising the primary literature covering their fields, and the various national government departments active in science-based and other industries, which need to provide information services for their staff and customers.

The machine-readable databases produced by the first sector of the industry are leased from their producer by the service suppliers or vendors—organisations which have developed software systems to enable users to search the machine-readable databases which have been loaded into the suppliers' computers. This interaction is effected by using remote computer terminals linked by standard telephone equipment over national and international communication networks to the host's computers. The database producer's magnetic tapes are converted into a format compatible with the supplier's retrieval system. In this process the tape data format is analysed and design specifications are developed to transfer the information from the tapes to the magnetic disc used in the supplier's system.

The third sector of the industry embraces libraries, information services and information brokers, who utilise the services offered by the producers of the databases and the services suppliers to provide information, both bibliographical and referral, for their users in the industrial, commercial, public, legal and academic sectors. (Houghton & Convey, 1984)

Microcomputers in IR

Because the low cost of microcomputers has now brought them within the reach of many small organisations or individuals, they are being used in new application areas. There is a powerful psychological appeal in having a computer system that is under one's direct

control; difficulties in the past trying to obtain congenial systems from central data processing departments provide further strong incentives for library and information units to establish their own systems.

The problem is the lack of suitable packages for IR. As the cost of microcomputers decreases, the cost of writing the systems to use on the machines becomes more conspicuous. Many library and information services cannot afford custom-built software (which now costs several times the cost of the computing equipment). The alternative of having internal staff write the programs may hide the costs involved, but it introduces all the problems of learning the new discipline of programming. (Vickery & Brooks, 1980)

However, nearly all microcomputers offer word processing facilities, and these can be used for entry, updating, and printing of such material as serials lists, bibliographies, and guides to local reference sources. A microcomputer is also suitable for handling in-house reference files containing data relevant to the library.

Cataloguing is practicable on a microcomputer only for a small collection, but other functions such as circulation, borrow-checking, and order processing can be implemented. (Williams, 1979)

On-line searching of the commercial databases can also be done via the microcomputer, and retrieved records can be stored locally and integrated with local citations to produce bibliographies, or they can be compared with the local collection. Some suggestions have been made for local networking to allow libraries in the same area to share reference files and use electronic massaging.

Most research and information workers accumulate a collection of reports, papers, bibliographic references, leaflets, and catalogues. These items remain potential, not actual, sources of information unless their contents are accessible. A microcomputer system can be used to index, store, and retrieve this type of information as it is needed.

Many microcomputers now have communications facilities and can serve as terminals to larger systems or can communicate with other microcomputers. They can be programmed to emulate any standard terminal, and software for this is becoming more widely available. A microcomputer can also be programmed to access teletext and viewdata services and electronic mail systems.

9.1.3 Development of IR Systems in China

Compared with the advanced countries, China is left behind in the development of IR systems. The present situations can be described as follows:

1. Conventional means of IR methods predominate for the time being;
2. Few international online terminals have been installed due to financial and technological barriers;

3. Many databases and searching softwares are still at the experimental stages;
4. Difficulty in the processing of Chinese characters has been a great barrier to the development of computer-based IR systems.

The initial trial of a computer-based IR system started in 1975 in China. Through a ten year effort, especially since 1983 when the establishment of a national IR system was put in the list of national key research projects, great progress has been made; many ministry information services have set up their own on-line IR systems, with certain hardware and software resources and more than ten cities have installed international online terminals.

For the time being, there exist three main types of computer-based IR services in China:

1. International On-line Terminals—providing IR services with 361 databases available in ESA-IRS, DIALOG, and ORBIT etc. It started in 1980 and has searched 21,000 requests since then;
2. National on-line IR services—providing searching from CRA tapes. It started in June 1982 and has searched several thousands of requests;
3. Introduction of Tapes—providing off-line SDI services. More than 20 types of tapes were introduced in 1980. It has increased up to 54 by the end of 1985 and the totality has reached 30,000,000 items. The number of requests searched has reached 16,000.

It has been estimated that the proportion of utilisation of bibliographic databases, numerical databases and factual databases are 80.4%, 12.4 and 7.2% respectively.

During the period of the Sixth-five plan, China has introduced 52 bibliographic database tapes and has produced 83 bibliographic and numerical and factual databases by itself. (Zhang, F-L, 1986)

Nevertheless, the pace of development is not fast enough, and the reasons are various:

1. The lack of unified programme and planning—the strength has been scattered so that the capacity of each database is small and could not exert an efficient effect;
2. The shortage of budgets, techniques and qualified technical personnel for indexing;
3. The lack of essential policies and strategies, and standards.

It has been realised that the emphasis should be put on the development of bibliographic, numerical databases, and factual databases, which include bibliographic information (books and periodicals), conference, patents, practical techniques, marketing, news and on-going research projects etc. It is necessary to expand and improve the Chinese thesaurus.

It has been indicated that in China the number of potential users is huge, but the number of actual users is few. The reasons of low utilisation of computer-based IR services in China can be summarised as following:

1. Lack of awareness (consciousness) of the existence of the services;
2. Difficulties in access to the services;
3. High cost of the services; and
4. Low satisfactory level of searching results.

At present, an urgent problem faced is to enhance unified planning and to avoid low-level duplications. It calls for networking and resource-sharing at the moment of continuous development of databases.

With much attention and effort in the development of computer-based IR systems, we should not misinterpret the situation and assume that China's IR systems can be transferred from a conventional mode to a computer-based mode soon. If we examine the present situations of IR services, we will feel the necessity of improving the conventional IR services at the same time as developing of computer-based services. The reasons are two-fold:

1. Conventional IR services are the basis of computer-based IR systems. It is important to have an unified plan in producing comprehensive, complete, up-to-date and high quality secondary sources;
2. Computer-based IR services will not be widely in use in the near future. Conventional services has already had some solid material foundations and should exert the biggest possible effects until computer-based systems can replace them partly or entirely—without reducing the effectiveness of the services and user satisfactions.

9.2 Design Issues of IR System

9.2.1 Definitions

IR or Literature Searching

IR here means any activity in which a search of the literature is conducted to find bibliographical material on a particular subject. The search may be performed in a "conventional" manner, using card catalogues, printed indexes, and other manual tools; or it may be conducted less conventionally, using a subject index in a form that is not completely manual. The most sophisticated and "least manual" of such searches is via a computer; that is, a computer-based IR system. The end product of a completely manual literature searching is likely to be a group of actual documents delivered to the requester, although it may be simply a typed lists of references to, or abstract of, documents. The end product of a machine literature search is likely to be a printed list of citations or abstracts that satisfy some logical search requirement—such list generated on a computer high-speed printer or some other piece of equipment peripheral to a computer installation. (Lancaster, 1977)

IR Function of a network attempts to locate packages of information or answer factual questions by utilising available access points to a database such as author, title, subject headings, classification numbers, etc.

Database

Databases have been defined in the Directory of online databases as collections of related textual and/or numeric data in machine-readable form that are processed for computer-based publishing and/or electronic dissemination. Databases may be classified into "reference" and "source" databases.

On-line IR

The term on-line refers to the fact that the searcher is in direct communication with ("on-line to") the database he wishes to interrogate and to the computer on which it is loaded. A search is conducted as a two-way conversation between searcher and the system (computer). For this reason the on-line system is frequently referred to as interactive or conversational. (Lancaster, 1979)

Off-line IR

In off-line IR, the accomplishment of functions is not a part of the main processing operation. (Prytherch, 1987)

SDI

SDI stands for selective dissemination of information. In SDI, search strategies are prepared to represent the current awareness information needs of individuals. These search strategies, usually referred to as "user interest profiles," are put into machine-readable form, stored on magnetic tape, and matched at regular intervals, perhaps monthly, against new additions to the document database. (Lancaster, 1979)

RS

RS stands for retrospective searching. In RS, the matching of a query against a retrospective file (i.e. a file going back in time). The searcher usually has the option of defining the period of time over which the search will be made. (Taylor, 1980)

9.2.2 Components of IR Systems

According to Lancaster (1979), an IR system may be considered to comprise six major subsystems in terms of operations:

1. The document selection subsystem.
2. The indexing subsystem.
3. The vocabulary subsystem.
4. The searching subsystem.
5. The subsystem of interaction between the user and the system (user-system interface).
6. The matching subsystem, that is, the subsystem that actually matches document representations against request representation.

In a "conventional" computer-based system, the computer contributes directly only to the matching operation. It acts as a giant matching device. But, in most systems at least, it contributes nothing directly to the selection of documents, the indexing of documents, the control of the vocabulary used in indexing and searching, the preparation of search strategies, or the interaction with system users. These are all intellectual activities, performed by humans in most existing systems, and these intellectual activities govern the effectiveness of the system.

The major important factors controlling the effectiveness of a retrieval system may be separated into two groups:

—Data base factors; and

—Factors associated with the exploitation of the data base.

The major data base factors, which can also be regarded as "input factors," are three:

1. What documents are included.
2. How completely and accurately the subject matter of these documents is recognised and represented in the indexing operation
3. How adequate is the vocabulary of the system to represent the subject matter of these documents.

There are also three "exploitation" or output factors:

1. How well the staff of the information centre is able to understand the information needs of the users (user-system interaction).

2. How well they can transform these needs into searching strategies.
3. How adequate is the vocabulary of the system to represent the subject interests of system users. (Lancaster, 1979)

9.2.3 Design Issues

When designing and planning an IR system in a network environment, the following should be taken into account:

1. Objectives, Policies, Standards and Commitment;
2. Structure:

   Centralised or distributed in terms of management, hardware configurations, software and database production and services;

3. Modes of IR services:

   Conventional or computer-based, or both; if computer-based, off-line or online or both;

4. Types of Services:

   SDI or RS, or both;

5. Hardware Considerations

   - Types of Hardware
   - Compatibility of Hardware
   - Installation of Hardware

6. Software Considerations

   - Types of databases available
   - Requirement of IR searching packages
   - Decision about purchase or design of databases
   - In-house database design considerations

9.2.4 Effect of Networking on IR

This is an area that can benefit greatly from co-operative efforts. The resource used in the IR (reference) function are among the most costly to acquire. CA programmes in obtaining these reference works can help to reduce these costs. Furthermore, if access to informational databases is considered to be analogous to the problem of "collections development," a similar saving can be obtained. The access point(s) may be centrally or hierarchically located,

in which case member libraries obtain access by phoning or using teletype to place requests. Finally, if the IR function is to be carried out efficiently, the technology to implement a reasonably fast response, and minimise human handling of requests, is necessary. This technology, especially if computer-based, can usually be purchased more economically by a network than by the individual libraries. Furthermore, the software and hardware to support these communications activities can be readily maintained through the network than through the member libraries.

IR seems to be one area that always demands inter-system dialogue. It would usually not be feasible for local networks. The immense effort involved in creating a database, indexing, abstracting, up-dating, forwarding of materials from the database seems to require the specialised efforts of "information brokers." Thus, the mechanised database is viewed as a resource in the same vein as the printed reference work; and the database supplier is analogous to the publisher/supplier of monographs, periodicals or more traditional non-print materials.

Under the following heading, the possible models (national, regional) of IR system in China are discussed in terms of objectives, structures and technical considerations etc.

9.3 Descriptive Model of IR Systems in China

9.3.1 National Sci-tech IR System

When planning a national sci-tech IR network, the following should be taken into account:

1. Its own circumstances; distribution of computers and databases, information need and possible technical input etc;
2. Social and economic effects; Emphasis on items with quick efficiency, easy fulfilment and easy management;
3. International Standard; foundation of further expansion and development, and foundation of the use of Public Data Switch Network (PDN);
4. Mainly Self-reliance, and supplemented by the introduction of necessary techniques when implementing the plan, i.e. hardware or software mainly Chinese makes; if imported, Chinese technicians will be used to maintain the systems.

Policies and Strategies

The key issues in the policies and strategies are the following:

1. Standardisation;
2. Centralised selection of topics;

3. Decentralised processing;
4. Co-ordinated database building; and
5. Formation of distributed comprehensive databases.

In accordance with the above principles and the existing state of China's information industries, it is recommended that the regions with PDN, make use of PDN first to develop their own sub-networks, then the national tree- shaped network can be established by linking sub-networks with the centre (Beijing) based on X.25 standard. Once the national PDN is established, the centres of regional network can be linked with the nearest interchanging joint(node).

Configuration

It is proposed that a modified star, i.e. tree (hierarchical) configuration is suited to China's national sci-tech IR system. The reasons might be claimed to be the following:

1. The existing IR systems in each ministry can be used as subsystems of the national system;
2. The information centres in Beijing area are connected to form Beijing regional IR subnetwork, in which users address requests to their own centres first, if dissatisfied, then forward the request through ISTIC;
3. Each region may set up its own regional sub-networks first. The users address requests first to their regional centres, if dissatisfied within regions, forward the requests across regions or ministries through ISTIC. Such route policies will therefore lessen the burden of ISTIC and traffic of telecommunication;
4. A Tree-shaped configuration has a high degree of flexibility; it is feasible to put the sub-networks into use as soon as they have been established. It suits the programme of investment and establishment in batches.

Long-term Plan

ISTIC has therefore prepared a detailed plan for the establishment of a comprehensive, computerised information network centred at the institute. This plan envisages that system will be built up over a period of 15-20 years in a series of three stages as follows:

First stage: Off-line services (five years)

The main tasks of this period are: the founding of professional document stocks in Chinese and ocidental languages with tapes imported or produced in China(including the tapes accumulated in typesetting); providing SDI and retrospective search services; and supplying on-line retrieval services on a small scale.

Second stage: On-line retrieval work (five years)

In this stage, all subsystems accomplished in the first stage will be assembled and linked so that all data may be utilised and a higher efficiency will be achieved. The on-line services will be expanded and extended from the former small-scale on-line services within the Institute itself to services in the medium scale.

Third stage: A network (five years)

At this stage the new system will be completed, and its on-line range will be expanded to a broader coverage eventually with the aim of a nation-wide on-line retrieval network, the final aim being to become part of the world networks.

In the process of getting acquainted with these new techniques, ISTIC has been experimenting with on-line linkages with international databases. The plans outlined above are also dependent on external aid, and ISTIC is envisaged to establish the hardware components of the system mainly through the financial assistance of United Nations Development Programme. Experts have also been delegated from Unesco to assist ISTIC in its concrete plans for modernisation.

However, the hardware and the basic software requirements will presumably have to be met through imports, since the domestic electronics industry capacity has failed to catch up with advanced producers. China is not able to raise the total amount of funds required, and assistance from international agencies has been essential and is likely to be required in the future too. The absence of large-scale financial commitment by government threat to the realisation of such plans for advanced computer-based information systems.

But there are other problems of an infrastructural nature which pose equally serious obstacles to plans for advanced networks. A primary factor is the lack of adequate telecommunication facilities. In China, the ambitious communications satellite program formulated in late 1970s appears to have been scaled down, and a postponement till mid-1980s happened. Additionally, the local networks being based on non-digital switching technologies and with limited line capacities, seem unable to support a true on-line network. One apparent symptom of this state of affairs is that very few large computers work on a time-sharing basis, although there is no doubt that China will be able to set up more or less centralised computer-based network (including the indigenous capability of installing the equipment) arrives by the end of the century. (Barrk, 1985)

9.3.2 National Agricultural IR System

As a sub-system of National Sci-tech Computerised IR system, the National Agricultural IR system will be set up in accordance with the overall principles and its own characteristics. The system can be described under the following headings.

Objectives

1. To establish several computerised IR systems comprising minicomputers and microcomputers, based on the existing foundation of the centres at different levels;
2. To provide various agricultural IR services nation-wide by utilising the foreign tapes introduced and domestic databases produced;
3. To promote the realisation of resource-sharing by the efforts of the national centre and regional sub-centres to provide off-line and on-line IR services.
4. To build up a set of agricultural bibliographic, factual and numerical databases, which will store at least 3,000,000 items by the end of the Seventh-five plan.

System Structure

1. Organisational Structure

   The national Agricultural Sci-tech IR system will be a sophisticated hierarchy with multiple levels. It will be such a computer IR network which links CAAS, seven regional centres, provincial (municipal autonomous) academies of agricultural sciences, agricultural universities, specialised institutes and users. The STDIC-CAAS will be the centre of the computer-based IR system and co-ordinating organisation. It is responsible for the link with the National Computerised Sci-tech IR centres and the centres in other fields. (Figure 9.1)

2. Hardware

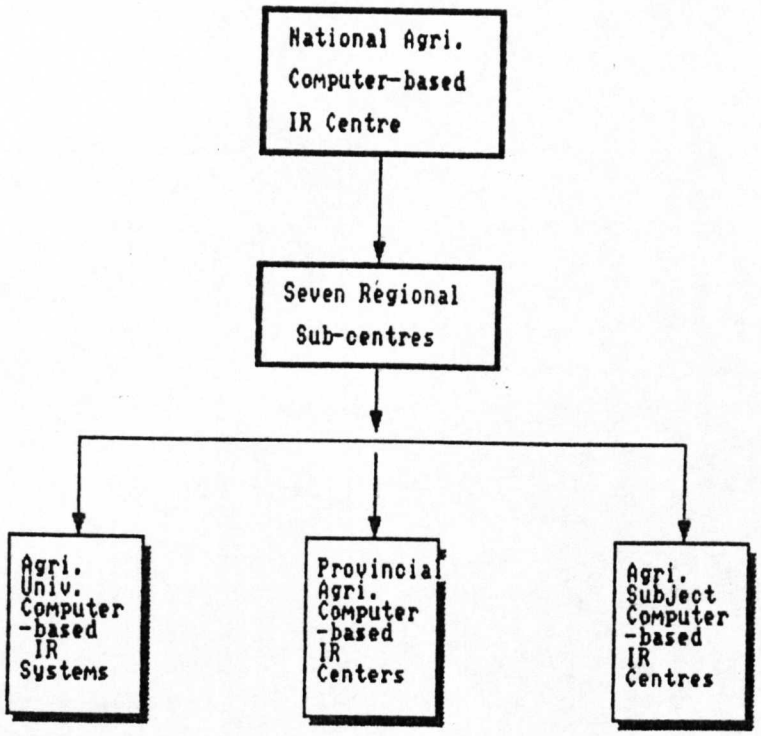
   The National Centre will be equipped with a main-frame computer, and it will be in charge of the processing of agricultural sci-tech information and provide the IR services nation-wide. Meanwhile the provincial (municipal and autonomous) academies of agricultural sciences, and agricultural universities should be installed with compatible computers with an emphasis on the application of minicomputers and microcomputers. They are responsible for the processing of their own documents and providing necessary services to researchers and teachers in the area.

   To fulfil the objectives mentioned above, and to satisfy a wide range and a big number of requests, it is desirable that the national centre is equipped with a middle-sized computer system in principle. However, due to the limited funds, it is more practical to use the existing HP3000 system first, and then transit to middle-sized computer systems. It is suggested that the regional sub-centres, provincial centres, universities and specialised institutes purchase HP3000 compatible computer systems in order to realise the resource-sharing of agricultural information resources.

3. Databases and Softwares

   The national Agricultural Sci-tech IR system will build several databases and sub-databases according to the distribution of information resources. Preparations will be made through co-operation between the organisations in the system. The following databases have been planned to be set up within the Seventh-five-year Plan:

Figure 9.1: Organisational Structure of Agricultural IR System in China



(a) Foreign Agricultural Sci-tech database — importing the tapes of the existing foreign agricultural database through various channels but in a planned way, such as CAB, AGRICOLA, AGRIS, FSTA, CRIS tapes, then exploring and modifying them to suit the Chinese demands and circumstances;

(b) Chinese Agricultural Bibliographic Database — creating a comprehensive database which covers the basic foreign and Chinese literature on all subjects of agriculture. And in the database the information is stored, retrieved, displayed and printed all in Chinese.

(c) Fact and Numerical Database — building up a set of fact and numerical databases related to local area's production management, information investigation, sci- tech research and education etc;

(d) Agricultural Bibliographic Catalogue database — setting up a MARC National Agricultural Bibliography, which will be based on the catalogue of the STDIC-CAAS, and supplemented by the catalogues of other big agricultural libraries;

(e) Agricultural On-going Research Project database — establishing a database which covers the information and data about the whole process of the research projects, i.e. topic determination, design, execution, termination and achievements etc. The database will be up to dated on a regular basis so that the administrators can receive up-to-date information to help their management of those research projects.

(f) Searching softwares — importing or exploring searching software for both Foreign and Chinese databases and setting up HP-Chinese-English Workstations.

4. Telecommunications

   The installation of a national public telecommunications system is under way, which will make online at high level possible for the national agricultural IR system.

5. System Functions

   Users will be able to search the foreign and domestic agricultural information and relevant information on a resource-sharing basis.

   The system will consist of the following four main system functions:

   (a) Multi-lingual, i.e. Chinese, English and Japanese etc, storage and retrieval;

   (b) Transmission of the information into tape and disc forms for frequent and easy distributions.

   (c) Provision of both SDI and RS services; it will start with the small-scale on-line search and then develops into a network on-line search.

   (d) Editing and composition to publish the agricultural documents electronically.

6. Modes of IR

   Before the installation of the National Public Telecommunication Network, the system will carry out the computer-based IR service via the provision of the discs and tapes, and on-line searching in some parts of the country. Conventional means of IR will continue to exert its influence.

7. Types of Services

   Both SDI and RS services will be provided via conventional and computer-based IR system.

8. Application of Microcomputer

   The advantages of microcomputers have been greatly appreciated in China. It has been proposed that China's IR system should start with the application of microcomputers in each lower-levels of nodes. Since the centre of the system will be equipped with HP3000 computers. It is suggested that each of the lower levels should acquire HP-Chinese-English workstations and IBM compatibles. Therefore, resource-sharing, unified programming and assignment of implementation can be expected. As for databases, the dawn of of CD-ROM technology sent a ripple of excitement and the subscription and production of CD-ROM databases should be considered in terms of cost-effectiveness.

9.3.3 Provincial Agricultural IR Model, with particular reference to ZALINET

The direction of a provincial IR system can be decided by the following:

1. Its own circumstance and characteristics;

2. The roles that the provincial centres, agricultural universities, specialised institutes will perform in the national Agricultural IR services;

3. Information needs of local users etc.

Here, the second issue will be discussed in detail. If we review the Seventh-five plan, we can find that the National Agricultural IR Network will eventually link up the national centre with provincial centres—provincial academies of agricultural sciences, agricultural universities and specialised institutes. Those nodes have been assigned various tasks.

The regional and provincial centres have been assigned the following:

1. Organising and co-ordinating the building up of *local agricultural bibliographic* databases, union catalogues, on-going research projects and research achievements etc factual and numerical databases;
2. Undertaking the tasks of information collection and processing, and production of databases assigned from the national centre; and
3. Undertaking the tasks of agricultural information processing consigned by the local government and providing numerical databases in the form of tape and disc, etc.

And the tasks of agricultural universities have been identified as follows:

1. Setting up databases for the *university bibliographic* information, catalogue and the databases for the relevant fact and numerical data;
2. Providing SDI and RS services by utilising the databases produced by the national and provincial centres; and
3. Undertaking the tasks of collecting, processing of bibliographic, factual and numerical information consigned by the national and provincial centres, etc.

And the specialised institutes have been assigned the following tasks:

1. Organising the establishment of *subject* bibliographic, catalogue, factual and numerical databases;
2. Undertaking the task of collection and processing of subject information, and production of subject databases assigned by the national centre;
3. Providing services from numerical databases tapes and discs for the subject of interested; and
4. Carrying out IR services from subject bibliographic, factual and numerical databases, etc.

The national plan will certainly promote the development of IR in a province. The fulfilment of the tasks assigned by the national plan will bring out a solid material foundation for provincial IR systems. In a provincial network environment, there will be three or more nodes linked with the national Agricultural IR Network. Thus those nodes can become centres or sub-centres for provincial IR Networks. In the case of ZALINET, ZAAS, ZAU, CNRRI and TRI have fallen into the above three categories.

The IR system in ZALINET, therefore, can be briefly described in the following terms:

Objectives

1. To set up an IR system, based on the development of the nodes linked with the national network;
2. To provide various agricultural IR services province-wide by utilising the hard copies, tapes purchased or processed at the national network via conventional means or computer;
3. To build up a set of agricultural bibliographic, factual and numerical databases with local characteristics;
4. To fulfil the tasks of national plan with network efforts and resources-sharing.

Configuration

The ideal configuration for an IR system in a provincial network will be a (composite) star. It is decided by the following:

1. Development of the provincial nodes at the national IR network;
2. The existing resources situations at lower level libraries and information centres, and the future possible input etc.

In ZALINET, ZAAS, ZAU, CNRRI and TRI are naturally centres or sub-centres. The link between centres and other nodes will be mainly by post and some telecommunication means.

Resources Development (including Hardware, Software)

The following resources should be acquired:

1. Funds and Qualified Manpower: dedicated funds and personnel;
2. Hardware: HP3000 or IBM Compatibles and other facilities, e.g. telecommunication facilities;
3. Databases: hard copies, tapes or discs or CD-ROM purchased or processed at national and provincial levels; and some in-house databases in microcomputers;

4. Searching Software: packages purchased or produced at a higher level.

Modes of Searching

The modes of search include both conventional and computer-based, but in the latter, mainly off-line in the early stages.

Types of Services

Both SDI and RS will be provided.

Installation of IR centres

ZAAS, ZAU, CNRRI and TRI will be the centres in the network. They should be equipped with the necessary hardware mentioned above in order to perform the roles. Generally speaking, their tasks are two-fold:

1. Providing IR services to other nodes—External Effect;
2. Organising and Co-ordinating the collection, processing of agricultural information, and production of local bibliographic, factual and numerical databases network-wide—Internal Efficiency.

Some orientation and division of functions among those centres should be worked out according to their subject bias, resource situation and geographical locations etc.

The selection and subscription of databases for services in the centres should be carefully made based on the unified plan and cost-effective analysis.

When designing and planning in-house databases, the following should be considered:

1. Input Factors:
   - types of database: bibliographic or fact or numerical;
   - data to be included: categories, scale, period of time etc;
   - format: ease of use, standard; and
   - indexing: accuracy, complete, experience of indexer etc;
2. Training of staff into qualified indexers, intermediary and training of users to be familiar with retrieval tools and methods.
3. Application of microcomputers in the in-house system.

9.3.4 Identification of the Components in Three Programmes

As we have reviewed, IR services can be carried out by different modes. The evolution sequence is regarded as:

Manual → Off-line → On-line → CD-ROM in Microcomputer

However, the development has progressed at a different rate in different countries. In some advanced countries, the on-line IR services has become very popular while in some developing countries, the manual IR services is still underdeveloped. It it noteworthy that a developing country does not necessarily follow the evolution sequence since new technology (e.g. CD-ROM) sometimes provides more cost-effective means, which saves much time in trial.

The main advantage of a computer-based system is obvious: the ability of handling very complex searches, at high speed. But setting-up a computer-based system requires high initial investment.

Which modes the IR system in the network will adopt should be based on a careful comparison between those modes. Following the overall principle, three alternative programmes are chosen for comparison. They are manual IR system, Off-line IR system and On-line IR system.

Manual IR system

By a manual IR system, the author means that the network will carry out a conventional IR service in a centralised mode. The centre (or centres) will be stocked with fairly comprehensive (usually expensive) printed retrieval tools (including abstract journals, index journals, references and bibliographies etc.). In the centre(s), a certain number of staff will be allocated to carry out manual searching.

Off-line IR system

By a off-line computer-based IR system, the author means that the network will set up a IR centre equipped with computer facilities. Utilising the IR software and bibliographical databases either purchased or established by national network in tape forms, the IR system will provide SDI and RS services in a batch mode. Some in-house databases dealing with local network special demand will be built by joint effort from member libraries.

On-line Computer-based IR System

By a on-line computer-based IR system, the author means that an on-line IR services will be provided. Here on-line implies several levels of on-line: 1) on-line between the provincial centre and international host(s); 2) on-line between the provincial centre with national centre; 3) on-line between the provincial centre and member libraries. The first two levels may not be accessible by individual members. Both SDI and RS services will be provided. The databases for services are mainly the databases available in national IR centres. As with off-line system, some in-house databases to meet local interest will be built.

Table 9.1: Means & Equipment involved in Three Programmes for IR

Activity Description	Program One	Program Two	Program Three
Question Analysis & Set-up	Manual	Manual	Manual
Searching	Manual	Computer	Computer
Output Processing	M/Photocopier or Typewriter	Printer	Printer
Distribution	M/Mail	M/Mail	Local Printer

The means and equipment adopted in each programme are identified and presented in Table 9.1.

9.4 Mathematical Model of IR System in China

9.4.1 Performance Criteria and Measures

When designing and planning an information service, one usually choose cost, time and quality as criteria. The specific criteria suggested by Lancaster (1979) for an IR system are the following:

Level 1. Effectiveness(consideration of user satisfaction)

A. Cost Criteria

1. Monetary cost to user
2. Other, less tangible cost considerations

B. Time Criteria

1. Time elapsing from submission of request to retrieval of citations

2. Time elapsing from submission of request to retrieval of document
3. Other time considerations

C. Quality Considerations

1. Coverage of the database
2. Completeness of output (recall)
3. Relevance of output (precision)
4. Novelty of output
5. Completeness and accuracy of data

Level 2. Cost-effectiveness (user satisfaction related to internal system efficiency and cost considerations)

1. Unit cost per relevant citation retrieved
2. Unit cost per new, that is, previously unknown, relevant citation retrieved
3. Unit cost per relevant document retrieved

Level 3. Cost-benefit (value of system balanced against costs of operating it)

In the framework (Figure 7.6), the criteria for the network being modelled have been chosen against cost, effectiveness, cost-effectiveness and cost-benefits. Here, the review of it is necessary.

More specifically, we have chosen recall and precision, ratio response time and user effort, cost-effectiveness and cost-benefits of IR as performance measures.

Recall

The term "recall" refers to a measure of whether or not a particular item is retrieved or the extent to which the retrieval of wanted items occurs.

Precision

The term "precision" refers to a measure of signal-to- noise ratio in certain kinds of information systems.

The two measures, recall ratio and precision ratio, can be illustrated further by a 2 × 2 table presenting the results achieved in a particular literature search (Table 9.2).

Therefore, Recall relates to the ability of the system to retrieve relevant documents, and precision relates to its ability not to retrieve irrelevant documents. The recall ratio is defined as

$$\frac{\textit{Number of relevant documents retrieved}}{\textit{Total number of relevant documents in the collection}}$$

Table 9.2: 2 × 2 Table of Results of a Literature Search

	User relevance decision		
	Relevant	Not Relevant	Total
Retrieved	a (Hits)	b (Noise)	a + b
Not retrieved	c (Missed)	d (Correctly rejected)	c + d
Total	a + c	b + d	a + b + c + d (Total Collection)

The precision ratio is defined as

$$\frac{\textit{Number of relevant documents retrieved}}{\textit{Total number of documents retrieved}}$$

The precision ratio and recall ratio, used jointly, express the filtering capacity of the system- its ability to let through what is wanted and to hold back what is not. Neither one on its own gives a complete picture of the effectiveness of a search.

Response Time

In a delegated search, this represents the time elapsing between the submission of a request by the user and his receipt of the search results. In a non-delegated situation, it represents the time involved in the actual conduct of the search; in this case, it also is a measure of user effort.

User Effort

In a non-delegated search, effort is measured by the amount of time the user spends conducting the search. In a delegated search, it is measured by the amount of time the user spends negotiating his inquiry with the system and the amount of time he needs, when the search results are delivered to him, to separate the relevant from the irrelevant items, which is directly related to the precision ratio.

All these criteria are closely related, and there are tradeoffs among all of them.

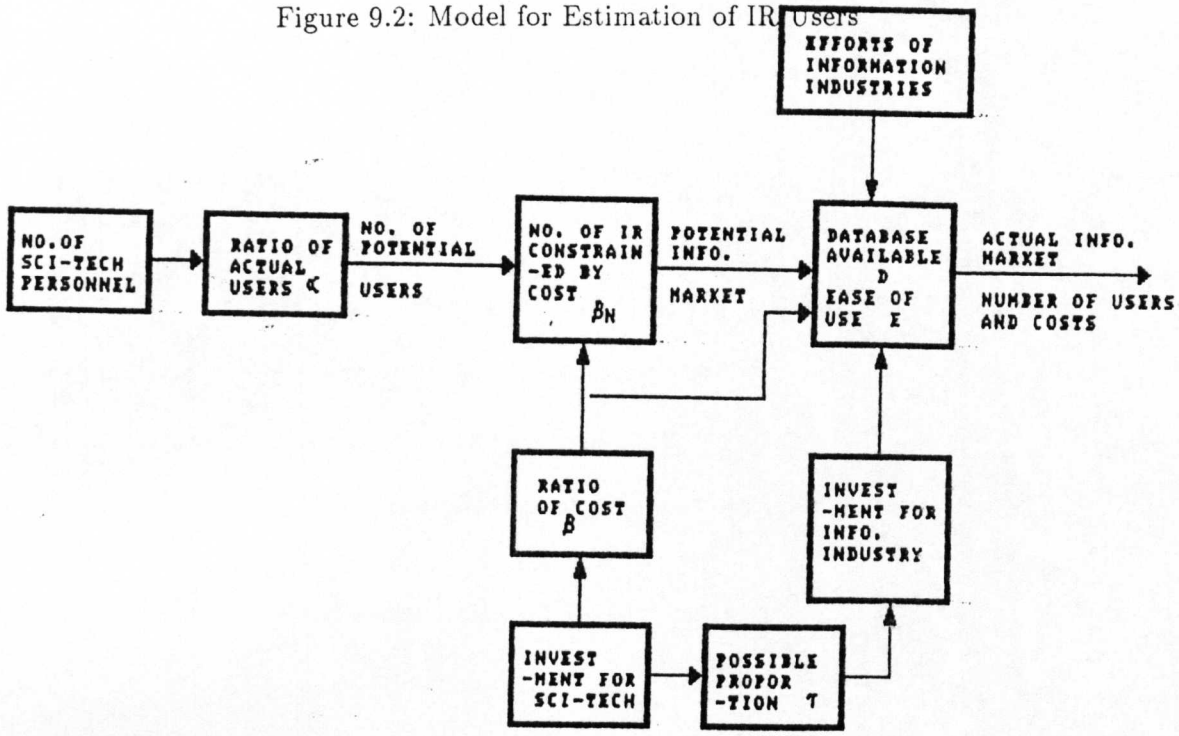
9.4.2 Modelling

Estimation of Potential Users of IR systems

How big the marketing of Scientific Information is dependent on the following:

1. Quality and quantity of scientific personnel in the country (area);

Figure 9.2: Model for Estimation of IR Users



2. Investment to the projects for the development of science;
3. Quality and quantity of Information Bank
4. Convenience and Efficiency of Information Services

Therefore, the actual number of IR users can be estimated according to the following flowchart (Figure 9.2).

Cost-effective Model

The network plans to carry out IR services but which is the most cost-effective mode should be decided after comparing the three common modes, i.e. manual, off-line, and on-line IR.

Here, the author assumes that once the manual mode is chosen, the services can be undertaken by each node, or at least by the upper two levels of nodes since only staff cost and the information (printed secondary sources) costs are involved. But if we choose the on-line or off-line mode, it is most likely that it is centrally or sub-centrally accessible since the setting-up costs will be very high (including databases, terminals and telecommunication fees) and it is more desirable to concentrate the resources in one or more centres.

First we are going to choose the most cost-effective mode i by the following formulae. Here we split the total cost into two parts:

1. staff cost(labour cost)
2. setting-up cost(including information, reproduction, equipment, space, and telecommunication costs etc).

Here information includes either printed secondary sources or databases.

The staff cost can be converted into cost of searching, i.e.

staff hour/per search $\times$ salary/per staff hour = unit staff cost of a search(C_i^r)

The author assumes that there are r request entering the network each year. So the staff cost per year is $C_i^r r$.

Therefore, the total costs for searching by i mode per year is

$$(C_i^r r + C_i^x)x_i$$

Then the author sets some goals for effectiveness measures, i.e.

$$\frac{1}{r}\sum_{i=1}^{I} Er_i x_i \geq Eor \leq E$$

Where E is effectiveness measures, which can be precision ratio, recall ratio and response time, or combination of the first two etc. It is subject to the staff and budget constraints.

The whole formulation can be expressed as follows:

$$Min \sum_{i=1}^{I}(C_i^r r + C_i^x)x_i$$

$$X_i = 0, 1$$

$$\frac{1}{r}\sum_{i=1}^{I} Er_i x_i \geq Eor \leq E \quad \text{(Goal)}$$

s.t.

$$\frac{1}{N}\sum_{i=1}^{I} S_i x_i \leq S \quad \text{(Staff Constraints)}$$

$$\sum_{i=1}^{I} C_i^x x_i \leq B \quad \text{(Budget Constraints)}$$

where

C_i^r is unit staff cost of a search;
C_i^x is setting-up cost;
r is number of request annually;
x_i is integer variable for modes;
E is effectiveness measures for specific modes;
E is desired effectiveness measures;
S_i is number of staff needed for specific modes;
S is number of staff available; and
B is budget available.

Once the mode is determined, we should decide the locations of the IR centres. Again, we can, using the cost-effectiveness measure and geographic accessibility measure, determine the optimal number and locations of IR centres. The total cost of IR service in the network is

$$Min \sum_{j=1}^{J} (C_{ij}^r r_{ij} + C_{ij}^x) x_{ij}$$

$$X_{ij} = 0, 1$$

$$(\text{Goal}) \frac{1}{r} \sum_{j=1}^{J} E_{ij} r_{ij} x_{ij} \geq E \text{ or } \leq E$$

$$(\text{Goal}) \sum_{j=1}^{J} D_{j(j+1)} r_{ij} / \sum_{j=1}^{J} r_{ij}$$

s.t.

$$\frac{1}{J} \sum_{j=1}^{J} S_{ij} x_{ij} \leq S$$

$$\sum_{j=1}^{J} C_{ij}^x x_{ij} \leq B$$

where

C_{ij}^r is unit staff cost of a search at node j;
r_{ij} is number of request entered at node j annually;
C_{ij}^x is setting-up cost of IR services at node j;
x_{ij} is integer variable for node j at mode i;
E is effectiveness measure at node j under mode i;
$E_{ij} r_{ij}$ is desired effectiveness meaure under mode i;
$D_{j(j+1)}$ is expected distance from other node to node j;
S_{ij} is number of staff needed at node j for mode i;
S is number of staff available; and
B is amount of budget available.

The optimising solutions will give out first the most cost-effective mode, then optimum number of centres and locations.