Scientific Communication, Information Flows in Industry

- Exemplified by Pharmaceutical Information in China & the UK

Thesis Submitted for Ph.D Degree

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ABSTRACT

This study compare information flows in China and the UK with the example of pharmaceutical information. The general objective is to explore the relationship between information situation and the status of science and industry in a country. In China scientific information has long dominated information flows while in the UK scientific information in dominance has gradually been changed to industrial information flow in dominance (i.e. information work by, for and associated with industry).

After background study of information communication environment and medicines research in China and the UK, scientific communication and S&T information flow are firstly studied, taking examples from pharmaceutical sciences.

Then the thesis proceeds into studying pharmaceutical information flow which includes not only scientific information but also business information, drug information, patent information and statutory information. A systematic comparison has been carried out to describe pharmaceutical information flow infrastructure; wider system of the information flow; information flow performance; relations among scientific information, business information, drug information, patent information and statutory information; relationships among system (pharmaceutical information flow), wider system (national pharmaceutical industry), general information environment, and special environment "national drug situation/pharmaceutical activity".

The industry's role in pharmaceutical information flow in Britain and China reflects the fundamental difference in the two countries' situation. In the UK, pharmaceutical industry play a central role in the pharmaceutical information flow. Some information are directly related to the industry such as S&T information, patent information and business information, some are indirectly associated with the industry such as drug information and statutory information. The big industry, big science and big information may reflect the UK situation. On the other hand, pharmaceutical information flow in China is mainly S&T information flow and is not closely linked with the industry. The less sophisticated pharmaceutical industry has a premature "nerve system"- information flow. The very limited industry involvement in R&D and therefore in information work reflects the little industry, little science and little information in China.

DECLARATION

No part of this thesis has previously been used for another degree or qualification in this institution or any other institutions of learning. The responsibility for the study is entirely the author's.

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Table of Abbreviations

ABPI	The Association of British Pharmaceutical Industry
ACTC	The Application for Clinical Trial Certificate(UK)
ADR	Adverse Drug Reaction
AMS	American Men of Science
AMWS	American Men and Women of Science
APS	Acta Pharmacologica Sinica(China)
BA	Biological Abstracts
BJCP	British Journal of Clinical Pharmacology
BL	The British Library
BLDSC	The Document Supply Centre, British Library
CA	Chemical Abstracts
CCETP	The China Commission for Editing Translating and Publishing
CEDD	China Enterprises Directory Database
CFP	The State Commission of Family Planning(China)
CJCP	Chinese Journal of Clinical Pharmacology
CMR	The Centre for Medicine Research, ABPI(UK)
CNCM	The China National Cooperation of Medicines

CNCPI	The China National Cooperation of Pharmaceutical Industry
CNCPFT	The China National Cooperation of Pharmaceutical Foreign Trade
CNPIEC	The China National Publishing Import and Export Cooperation
CPA	China Pharmaceutical Abstracts
CPO	Chinese Patent Office
CPT	Clinical Pharmacology and Therapeutics(USA)
CSM	The Committee on Safety of Medicines(UK)
CSTDI	China Scientific and Technical Documentation Index
DI	Drug Information
EJCP	European Journal of Clinical Pharmacology(Germany)
EM	Excepta Medica
EPO	European Patent Organization
FDA	Food and Drug Administration (USA)
FRS	Fellows of Royal Society
FSTDI	Foreign Scientific and Technical Documentation Index (China)
GCP	Good Clinical Practice
GDP	Gross Domestic Production
GLP	Good Laboratory Practice
GMP	Good Manufacturing Practice
GP	General Practitioner

IJCPT	International Journal of Clinical Pharmacology and Therapy(Germany)
IM	Index Medicus
IND	The Investigational New Drug Application(USA)
IPA	International Pharmaceutical Abstracts
ISTIC	The Institute of Scientific and Technical Information of China
IT	Information Technology
JCP	Journal of Clinical Pharmacology (USA)
JCR	Journal Citation Report, Science Citation Index
MPH	The Ministry of Public Health (China)
NCE	New Chemical Entity
NI	National Income
NHS	The National Health Service (UK)
NL	The National Library of China
OECD	Organization for Economic Cooperation and Development
PA	Physical Abstracts
PDL	Patent Documentation Library (China)
PI	Pharmaceutical Industry
R&D	Research and Development
RMB(¥)	Ren Min Bi(Yuan)
RPI	Retail Prices Index
RPSGB	The Royal Pharmaceutical Society of Great Britain

RSC	The Royal Society of Chemistry(UK)
SA	Science Abstracts
SATCM	The State Administration of Traditional Chinese Medicine
SCI	Science Citation Index
SDI	Selective Dissemination of Information
SPAC	The State Pharmaceutical Administration of China
SRIS	The Science and Reference Information Service, British Library
SSB	Scientia Sinica:B(China)
SSTC	The State Science and Technology Commission (China)
S&T	Science and Technology
TCM	Traditional Chinese Medicines
WHO	The World Health Organization
WM	Western Medicine

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Chapter 1 Introduction

1.1 Science and Communication, Industry and Information Flows

Science is a process which does not proceed by simple cumulation of knowledge but by creating a sequence of theories which continue to refine, extend or replace each other. Science is an activity, in which scientists generate, disseminate information on one hand, search, use and assimilate information on the other. Just like science and its communication always go hand in hand, modern industry and information are usually bonded together. Some studies divided the modern history into pre-industry, industry and post-industry phases and characterized the post-industry phase by so-called "information society" (Vickery, 1987).

After the World War II, along with the industrialization movement world-wide, there is a trend from "little science, little industry" towards "big science, big industry". This transition is reflected not only from the exponential growth in the size of science but also from the ever tightening link between national R&D and national economy. (Price, 1963) In this movement, in the industrial developed countries, scientific information in dominance has been changed to industrial information in dominance (i.e. information work for, by and associated with industry). The wide application of information technology (IT) and great information demands from industry, i.e. the technology push and the market pull, have enabled information flow in industry and information flow associated with industry to grow very rapidly. We may call this as ***industry led, driven and oriented information flow.***

In developing or less industrialized countries like China, the situation of information flow is quite different. Lack of the technology push and market pull prevents the information flow from quick growing. Purely scientific information has long dominated the information flow in China. Information work is confined to libraries and S&T information institutes.

Now a few words on the term "information flow" are needed. There are two definitions-one is narrow and one is broad. A common and narrow use of the term implies the spontaneous or automatic spread of information. The term "information flow" could also be used in the other broader sense of information transmission whether from person to person direct or via some intermediary store such as a book, journal article or computerized file (Hill, 1987). In this thesis, the latter meaning of information flow is adopted as an analogy with water flow.

Before proceeding to describe the whole study, we still need to explain the term "pharmaceutical information" firstly.

1.2 The Many Faces of Pharmaceutical Information

A person unfamiliar with the modern pharmaceutical industry and pharmaceutical activity, is more likely to understand *pharmaceutical information* as that contained in drug compendiums or medical handbooks. To a person familiar with the pharmaceutical industry and pharmaceutical activity, however, pharmaceutical information means many things relating to the industry and national pharmaceutical activity. It may be scientific and technological (S&T) information for drug research and development (R&D), or business information for finance, project or marketing managers in companies, or product information stored and managed by company information scientists who provide drug information service to the health professionals or sometime to the public. Moreover, pharmaceutical information is also connected with drug legislation and regulation in countries. Finally, the pharmaceutical patent is of great value to the industry both as one kind of information source and in the sense of intellectual property protection.

In this thesis, a rough definition is given of *pharmaceutical information* as the information related to pharmaceutical research and development or to pharmaceutical products. It consists of five major types: S&T information, business information, drug information, patent information and statutory information. Sequentially, *pharmaceutical information flow* is composed of the five types of information flows.

Although this definition of ***pharmaceutical information*** may seem to be too broad, it does suit the unique purpose of this thesis, that is to compare information flow in China and UK with pharmaceutical information as the example.

1.3 A Comparative Study on Information Flows in Britain and China - with pharmaceutical information as the example

The stimulus to this project was the original idea of a comparative study on S&T information systems between China and UK proposed by the Library of Chinese Academy of Science (*Academia Sinica*) which is the sponsor for this Ph.D study. Such a project was expected to produce some useful recommendations on information issues for the undergoing S&T system reform in China. It has been recognized that only to enforce and enhance current S&T information work is not enough. There is a need to build up information flow for industrialization rather than simply for S&T.

In 1978, China launched the greatest economic reform since the foundation of P. R. China in 1949. Some major aims of this economic reform are to encourage foreign investment, to promote the trade with foreign countries; and to let market forces, beside the central planning, to determine the pattern of industrial production. Following the economic reform, in 1985 China started its S&T reform to orient the national S&T to the national economic reconstruction.

Some steps were planned to implement the S&T reform:

- to remedy the drawback of research institutes being isolated from industrial enterprises, scientists are encouraged to undertake projects with industrial potential. Whilst some projects with national priority will remain under the control of the State, most of R&D activities are to be undertaken according to the industry demands;

- the R&D budget will no longer be allocated by the central government as an average according to the number of staff in institutes, instead, R&D projects in applied science will be funded by project sponsors (mainly industrial sponsors) under the contracts;

- directors of research institutes will be given more power by the central government in deciding the research directions in their institutions;

- a new type of research institutions: National Open Laboratories will be set up for visiting scientists from the country and abroad, so that a better scientific communication environment will be established for Chinese scientists (White Paper, 1987 & 1990).

It seems that China is facing a turning point in its S&T history now. So far, many S&T administrative officials and scholars have been travelling around the world to learn other countries' experience in how to manage the national S&T under the industrialization process.

The worldwide modern industrial revolution started in Britain three hundred years ago. The UK remains as one of the most developed industrial countries in the world today. With respect to this, a comparative study on British and Chinese S&T information system surely is a very interesting and promising topic.

However, there are two problems in this comparison of S&T information system in China and UK, which cause some concern.

Firstly, in China **S&T information** is, at present, the most comprehensive or the highest level term for all kinds of information activities. In 1986, an international meeting of experts on national scientific and technical information policy in China gave the definition of scientific and technical (S&T) information. It was agreed that scientific, technical and ***economic*** information, encompassing purposive messages relevant to technical problem solving and decision making will constitute the definitive framework (ISTIC, 1986). However, in UK scientific information is mainly confined to information associated with science and technology. There are other kinds of information such as business information, statutory information etc. which are related with industry and are not usually included in the term of S&T information.

Hence, it would be better to avoid using "S&T information system", since S&T information does not mean exactly the same thing in the two counties. Instead, we use ***"scientific communication, information flows in industry"*** to describe the information situation in industrialization process in the two countries.

Secondly, such a study which is still too wide in subject, may not be suitable for a Ph.D study with very limited time and resource (manpower and funds etc.). With the help of the supervisor *Professor R. T. Bottle,* the author confined the topic to a subject area: ***pharmaceutical information*** under a principal guide-line that such a comparison, on one hand, should be able to best represent the modern information practice in the developed industrial country UK, so that China could learn the most from the selected model; and on the other hand, the comparison should be able to best reflect the situation of China's S&T information infrastructure as well as the trend of the reform in national economy and national S&T, so that information scientists in the UK and other countries could become familiar with the growth and development in science, industry and information flow in China.

The first year study, including literature survey and extensive consultation with Professor Bottle, other academic staff in the department of information science at the City University, and some information specialists in the UK pharmaceutical industry and information industry, has convinced the author that such ***"a comparison of pharmaceutical information flows in Britain and China"*** could meet the above principal guide-line nicely for the following two reasons:

First, the UK pharmaceutical industry has been in the world leading position for more than half a century. It is well known that the UK pharmaceutical industry is one of the information intensive industries in the country, because of its characteristics of heavy competition world-wide, high risk in business, heavy R&D investment and high profit. On the par with scientific information flow, other information flows have been growing significantly for the past few decades. All these information flows are either directly related with the industry such as scientific information, business information, patent information; or indirectly related with the industry such as drug information and statutory information. In this thesis, all these information come under the name "pharmaceutical information". **The pharmaceutical information flow in UK may be called industry led information flow and reflects the situation in today's "information society".**

Secondly, China is a country with five thousand year of civilization history and experience in using traditional Chinese medicines (TCM). Its pharmaceutical industry has experienced a rapid growth for the past forty years (over 10% growth rate per year during the last twelve years, seeing Chapter 3). Meanwhile, the medicines research has also developed very quickly, *walking on the two legs* of traditional Chinese medicine (TCM) and western medicine (WM). A national S&T information system has already been built up in the pharmaceutical field since 1949. And it is now facing the historical change under today's economic and S&T reform waves. **Pharmaceutical information flow in China is mainly S&T information flow; it is not closely linked with the pharmaceutical industry and reflects the information situation in less industrialized countries.**

To draw such a comparison and to make some recommendations for the Chinese S&T information reform is difficult and would be aided by an appropriate methodology. The soft systems methodology described by Checkland (1981) was used to complement the other more traditional methodologies used in this study.

1.4 A Soft Systems Approach

Systems engineering comprises the set of activities which together lead to the creation of a complex man made entity and/or the procedures and information flows associated with its operation. System analysis is the systematic appraisal of the cost and other implications of meeting a defined requirement in various ways. "Hard" systems thinking is goal-directed, in the sense that a particular study begins with the definition of the desirable goal to be achieved. The application of such methods to management problems, to "soft" problems in social systems where goals are often obscure, is called "Soft Systems" methodology (Checkland, 1981).

It is said that in engineering, hard system thinking is used to solve structured problems which can be explicitly stated. However, in social sciences, soft systems methodology must be applied to unstructured and ill-defined problem situations. Here, "what is a problem ?" itself becomes a part of the research.

The soft systems approach includes the following three major steps:

1. An expression to build up the richest possible picture of the problem situation.

2. Definition of a conceptual system model with the major features including system mission, measure of performance, decision taking process, subsystems, wider system-/environment, and resources.

3. Comparison of the system model and the problem situations and proposals for feasible and desirable changes.

As it is said before, this project is expected to provide some recommendations for the Chinese S&T information reform by learning from the advanced UK model. This study takes pharmaceutical information as an example. There are three reasons for the application of soft systems methodology in this project.

Firstly there some unstructured problem situations (see "Description of the Studies in This Project").

Secondly, a conceptual system model could be drawn from the existing advanced UK pharmaceutical information flow infrastructure. In fact "pharmaceutical information" is very much a western concept. Pharmaceutical information is not commonly recognized in China as having 5 elements (scientific, business, drug, statutory and patent information) normally associated with it in the West. In the UK, pharmaceutical information flow is associated and linked with the research based industry and the sophisticated national drug situation. Such kinds of pharmaceutical information flow do not exist in China where only S&T information flow is relatively well developed.

Thirdly, by comparing the Chinese problem situations with the system model drawn from the UK pharmaceutical information flow, we could "image" a hypothetical system for the pharmaceutical information flow in **future China**, and propose feasible and desirable changes to the current situations.

Accordingly this project is divided into three sequential parts: expression of problem situations in China compared with UK (Chapters 2-6); illustration of an advanced system (UK pharmaceutical information flow in Chapter 7) and a less developed system (the Chinese pharmaceutical information flow in Chapter 8); definition of a conceptual system model based on the UK situation, comparison of the system model with the Chinese problem situation and recommendation for the future system in China (in Chapter 9).

1.5 Description of the Studies in This Project

In soft systems thinking, to find out what are problems and to give the richest possible picture of problem situations is the first and the most important part of research. Chapters 2-6 will undertake the task of "drawing pictures".

Chapter 2 Different Information Communication Environment in Britain and China

Information is a social practice which exists in its environment. Chapter 2 gives the demographic and economic background of the two countries, a historic study of information communication in the two countries, and current communication environment (including mass media, transportation, information technology) in the two countries. This chapter provides a picture of **general** information environment for the soft systems study.

Unstructured problem situation-

Information environments in the two countries are in different stages of development, on different social economic bases. What are influences on pharmaceutical information flows in the two nations?

Chapter 3 Medicines Research in Britain and China

If the pharmaceutical information flow is taken as a system, the nation's drug situation/pharmaceutical activity (including consumption, production, and trade) is the special environment for the system. Furthermore, the national pharmaceutical industry is its wider system which will greatly determine the pattern of the pharmaceutical information flow.

The UK pharmaceutical industry has 4 major features: its products are the results of extensive R&D, are patent protected, are available on prescription only, and have significant world market share. The Chinese pharmaceutical industry mainly operates in the domestic market. Its products are not patent protected. It has only a small R&D capacity and international marketing capacity. UK has a well developed drug distribution and legislation system whereas China is developing its system up to the international standards.

In Chapter 3, the drug situation/pharmaceutical activity, the pharmaceutical industry and the features (organization, status and size) of modern pharmaceutical R&D in the two countries will be compared. Such an approach will serve as a **special background** to the study on pharmaceutical information flow in Britain and China.

Unstructured problem situation-

If China modernizes its pharmaceutical industry, do its information flows need to change into the UK pattern?

The soft systems approach needs to "measure" the performance of existing system. This will provide some data for planning the reform of the current system and some experiences for operations research and system evaluation in the future system. Chapters 4-6 will describe the Chinese problem situations by "measuring" scientific communication performance in comparison with UK situation.

Chapter 4 The Growth of Science

One effect of the exponential growth in science world-wide since the 17th century is the so-called "information explosion". To study S&T information flows in China and UK, it is necessary to have an overlook on the scientific growth in the two countries as well as in the world. Chapter 4 measures the growth in the world and a few major countries (USA, UK and China etc.) in S&T manpower, literature, expenditure and studies impacts of the scientific growth on S&T information communication.

Chapter 5 Scientists' Information Needs Searching and Accessing Ability

In Chapter 5, the scientific information communication is to be studied from the input side (i.e. the information access). Two countries' scientists information need, searching ability and accessing ability are compared.

Unstructured problem situation-

Are Chinese scientists satisfied with the S&T information services? How effective is scientific communication in China?

Chapter 6 Scientists' Information Using Disseminating Ability

In Chapter 6, the scientific information communication is to be studied from the output side (i.e. the information use and dissemination). Scientific literature production in the two countries is first studied. Two countries' scientists' ability in disseminating information is compared. This chapter also discusses scientists citing behaviours and literature aging issues to study scientists' information using ability in the two countries.

Unstructured problem situation-

Is the capacity of Chinese scientists in disseminating and using information lower than British scientists? What are the causes or influencing factors?

Before the definition of a conceptual system model based on the UK situation, Chapters 7 and 8 will illustrate an advanced pharmaceutical information flow in UK and a less developed pharmaceutical information flow in China.

Chapter 7 Pharmaceutical Information Flow Infrastructure in Britain

As was said earlier, the pharmaceutical information includes not only the scientific information but also other information related to pharmaceutical industry and pharmaceutical activity. Chapter 7 includes the following sections: S&T information system in UK, business information in UK, information work in UK pharmaceutical companies, drug information system in UK, statutory information and regulatory system in UK, patent information and patent system in UK.

Chapter 8 Pharmaceutical Information Flow Infrastructure in China

In Chapter 8 the following sections are included: scientific information flow, business information flow, drug information flow, statutory information flow and Chinese regulatory system, patent information flow and Chinese patent system.

Unstructured problem situation-

Is it right to say that there is a little science (isolated from industry), a little industry (not research based) and a little information (not linked with industry activity) in China vs a big science, a big industry and a big information in the UK ?

Chapter 9 Pharmaceutical Information Flow in China Today and in the Future

Chapter 9 carries out a comparison of pharmaceutical information flows in the two countries within a systematic framework. It finally tends to draw some recommendations for a future pharmaceutical information flow system in China.

First the UK pharmaceutical information flow is assigned to a conceptual system S. Such a system has its *infrastructure*, *purpose/mission*, *measures of performance*, *boundary*, *wider system*, *environment*, and *subsystems* etc.. **Second**, pharmaceutical information flow infrastructures in the two countries is compared. **Third**, we compare the wider system "national pharmaceutical industry" in the two countries. **Fourth**, we compare the purpose/mission of the system S "pharmaceutical information flow" in the two countries. **Fifth**, from the stand-point of scientist as information generator and user, we will compare the performance of information flow in the two countries. **Sixth**, we will compare the information resources in the two countries. **Seventh**, there are five information flows (subsystems) interacting with each other in the whole pharmaceutical information flow (system). The relationships among subsystems will be studied. **Eighth**, pharmaceutical information flow exists within its special environment "national pharmaceutical activity", its wider system "national pharmaceutical industry" and its general information/communication environment in a country. The relationships among system, wider system and environment will be studied.

Finally, there will be some recommendations for the reform of current S&T information system and for the future pharmaceutical information flow system in China.

1.6 Other Methodologies Used in This Project

Apart from the soft systems method, the following methods are used in this project: *(i) social survey (literature survey, questionnaire, interview, and personal contact for data gathering) (ii) data processing (iii) bibliographical studies (or bibliometrics).* Because there will be detailed description of the methods or techniques in each of the following chapters, here we just discuss and assess these research methods generally.

(i) Social survey (literature survey, questionnaire, interview, and personal contact for data gathering)

The first and the most important problem encountered was collecting information or data for research. The major method of data collecting in this project is *social survey.*

To carry out a comparative study on information flow at such a wide scale, the literature survey has proved the most efficient way of data collection. In the UK studies, more data are collected from literature source, because many researches have been done in pharmaceutical information areas (Pickering, 1990, Jackson, 1987 etc.). The principal method for this project is to collect data firstly from the existing literature sources and secondly, when there is no literature source available, to collect data by means of questionnaires, interviews and case studies. In the China studies, more efforts have been made to collect first hand information by the author by means of questionnaire and interview, because there have been few studies on pharmaceutical information in China so far. Most of information or library studies are still concentrating on S&T information generally (Gong, 1990).

The **literature survey** was conducted under the subject Pharmaceutical Information by using the *Library and Information Science Abstracts* (LISA, UK) and scanning Chinese library and information journals.

Pharmaceutical information is one of the biggest subject area in information studies. Every year, there are hundreds of papers in this subject being indexed in LISA. The majority of them are written by the information scientists in the developed countries such as USA, UK, Germany, Italy, Japan etc., corresponding to the leading position of these countries in the world pharmaceutical industry. Generally the literature on this subject may be divided into the following five categories:

(1) Literature or information guide books such as *Guide to the Literature of Pharmacy and Pharmaceutical Sciences* (Andrews, 1986), *Information Sources in Pharmaceuticals* (Pickering, 1990), *Drug Information Sources* (Revill, 1984), *Information Sources in Medical Sciences* (Morton & Godbolt, 1984) and *Use of Chemical Literature* (Bottle, 1979 & 1991). These comprehensive books provide not only guidance in the use of the literature in the pharmaceutical field, but also an introduction to or overview on the information flow, work and practice in the developed industrial countries.

(2) Literature on information work and practice in the modern pharmaceutical industry. There are lots of papers of such kinds written by experienced information scientists in the industry (Brown, 1985; Cuddihy, 1975; Williams, 1984; Jackson, 1987 etc..) In the UK, there is a professional association for pharmaceutical information officers (AIOPI). Since the early 1970s, it has held conferences annually to discuss the current issues in information work in pharmaceutical industry and related areas. The most current issues include inhouse database system management, CD-ROM and Online applications, interlibrary loan and BLDSC, the changing NHS environment, ADR monitoring, postmarket surveillance, patent and drug legislation etc (AIOPI annual conference papers, 1985-1988).

(3) Literature on information work and practice in the National Health Service in UK (NHS). Many studies have been done on the national drug information network and information services provided by pharmacists. Some important authors include McNulty (1984), Hibberd (1980), Smith (1982) etc.

(4) Research papers on pharmaceutical information by the students of Department of Information Science at the City University, London. This department has provided post graduate education in information science for nearly two decades. Pharmaceutical information has long been one of the major directions of education and research of this department. Some research work have been accomplished by this department covering broad fields such as information work in the industry (Clark, 1985), information scientists in the industry (Jackson, 1975 & Augustus, 1981), IT in the industry (Byway, 1988) etc..

(5) Finally, about pharmaceutical patent and drug legislation/regulatory, many papers may be found from organizations such as Association of British Pharmaceutical Industry (ABPI), Centre for Medicines Research (CMR), Royal Pharmaceutical Society (RPSGB) etc..

In China, the information journal most relevant to pharmaceutical work is the *Medical Information Work Journal* published by the Ministry of Public Health (MPH). A scanning of this journal for the period of 1985-1989 shows that the majority of papers are concentrated in the S&T information work in academic institutions in China. The term *"pharmaceutical information"* is rarely used as it has been used in the UK and the West for so many years. This reflects the premature status of pharmaceutical information work in China. As a matter of fact, very few Chinese studies have looked at pharmaceutical information from the stand-point of this thesis, though it is a common stand-point in the West.

Questionnaire provides an economic method for large sample survey. In this project, five series of questionnaire have been designed and sent out to investigate the following situation in China: (1) scientists information need and satisfaction, (2) doctors drug information need (3) hospital pharmacists role in drug information provision (4) pharmaceutical manufacturers role in and need for information (5) information services in pharmaceutical industry (Appendix 5.1-5.5).

The above five series of questionnaire were designed against the existing similar survey in UK (Royal Society, 1981; McNulty, 1984; Williams, 1984 etc..); so that the comparison could be carried out correspondingly.

During the period of October - December, 1989, the author has conducted the questionnaire and interview survey in China. During which just under 500 questionnaire forms have been sent out with a response rate of nearly 50%. Additionally, the author visited all the major government departments in pharmaceutical field: Ministry of Public Health (*MPH*), State Pharmaceutical Administration of China (*SPAC*), State Administration of Traditional Chinese Medicines (*SATCM*); the major academic institutions in the field such as Shanghai Institute of Pharmaceutical Industry, the chemistry branch and the life science branch of Academia Sinica, Chinese Academy of Medical Science and Research Institute of Clinical Pharmacology at Beijing Medical University etc.; and six largest pharmaceutical manufacturers in Beijing and Shanghai. In addition, the national S&T information centres or libraries such as Institute of Scientific and Technical Information of China (*ISTIC*), The National Library of China (*NL*), and Chinese Patent Office (*CPO*) have also been visited for data collection. Being aware of the cultural difference between Chinese people and Westerners in their attitudes towards questionnaire, all the 5 series of forms were distributed and collected by the author personally in order to get the best possible response.

Throughout the three year study, with the help of Professor Bottle, the author has selected several typical information organizations for the UK case studies. In the national S&T information system, the author focused on the British Library, especially the unique central document supply system BLDSC. In 1990, the author visited the British Library Document Supply Centre *(BLDSC)* and the Scientific Reference Information Service *(SRIS)* for data collection. Furthermore, some academic libraries (*Loughborough University, Southampton University and School of Pharmacy of UCL*) have been visited and studied as examples of S&T information services in UK. In the study on information services and work in pharmaceutical industry, the author visited one UK owned large company *Glaxo* and the UK subsidiary of one multinational company (*Farmitalia*). Furthermore, the author has collected data directly from *ABPI* and *AIOPI*. To study the drug information service in UK, the author has visited and interviewed the information officer at *the Royal Pharmaceutical Society*. Business information for the pharmaceutical industry has a pivotal position in the UK pharmaceutical information flow. However, studies on this issues have been very scattered. Some case studies on information specialists (*PJB, Disclosure, SVP* and *IMS*) have been done by the author by means of visiting, interviewing, mailing enquiries, and personal contacts. Finally, the Centre for Medicine Research (CMR), as an unique information and scientific research resource in Europe on some aspects of pharmaceutical industry, was visited by the author in October, 1991. CMR was established by the ABPI in 1981 as an independent scientific unit to undertake research into the development and safe use of medicines.

(ii) Data processing

The second problem in methodology is the analysis of data.

The most widely used data processing method in this project is *tabulation*. To supplement the tables, some sorts of graphs have been drawn such as curve, bar, line and pie to demonstrate trend, composition, or share.

The *Lotus Manuscript* and *Harvard Graphic* software packages have been used in this project for data presentation and statistical analysis. The *regression* technique has been used in drawing trend curve or line particularly in the literature aging analysis in Chapter 6.

(iii) Bibliographical Studies

To study scientific communication, quite different from the above social survey methods, there is a quantitative or statistical method in information science namely **bibliometric studies**. Among the bibliometric studies, Bradford's law is about the concentration and dispersion of papers in journals; Lotka's law is about the concentration of scholarly productivity; the aging of literature is about the utility of literature over time; the citation analysis studies the relationship between citing papers or authors or journals and cited papers or authors or journals. In this project (Chapter 6), the bibliometric methods are to be applied to compare the scientific literature production by the two countries' scientists.

Chapter 2 Different Information Communication Environment in Britain and China

Information is a social practice which emerges from and develops always within the social environment that gives rise to demands for information. It is necessary that the general environment of information communication be explored carefully before the information flows be studied.

2.1 Demographic and Economic Background

China has an area of nearly 9.6 million square kilometres and a coastline extending to 18,000 kilometres. An official estimate in 1988 put the population at 1,096 millions. The mean rate of increase over the past decade is estimated to be a little over 1% per year. Six per cent of Chinese people belong to one of fifty-five ethnic minorities, the rest being of the Han race (Far East, 1989).

There are 26 provinces and autonomous regions (not including Taiwan) and three municipalities. The breakdown of the area and the population by administrative divisions is shown in Appendix 2.1. Xizang (Tibet), Xinjiang and Inner Mongolia autonomous regions and Qinghai province are huge but sparingly inhabited. Disregarding them, Sichuan province is the largest in both area and population. The three most populous cities of Beijing (the national capital), Shanghai and Tianjin together with their respective surrounding counties, have been administratively made into municipalities, which command provincial status. A region or province consists of prefectures, themselves made up of counties and cities. Several towns comprise a provincial county, and are in turn composed of villages.

China has a broadly based economy with expanding mining and industrial sectors; production of crude oil increased markedly in the 1970s. Since China started the economic reform in 1978, "Special Economic Zones" have been set up to encourage foreign investment for expansion of manufacturing; the inflow of capital was about $4,400 million in 1985 (including loans and direct investments) and has kept increased ever since. China's visible trade turnover totalled $102,790 million in 1988 which is about one third of the UK turnover. Major exports include crude oil, petroleum products and textile goods which account for half the total export volume (Howe, 1989 & Economists, 1987). About 61% of the Chinese labour force is engaged in agriculture and fishery, which accounts for 45% of the Gross Domestic Product (GDP) (Far East, 1989).

Britain comprises Great Britain (England ,Wales and Scotland) and Northern Ireland, and is one of the 12 member states of the European Community. Britain constitutes the greater part of the British Isles, a geographical term for a group of islands lying off the north-west coast of mainland Europe. With an area of some 244,100 sq. km., Britain is about the same size as the Guangxi Zhuang Autonomous Region or Guangdong Province, and half the size of Sichuan Province or Heilongjiang Province of China. The climate is generally mild and temperate. The population in Britain is estimated to be 57,065,000 in 1988 (Britain 1990).

Britain has an industrialized economy with machinery, chemicals and motor vehicles accounting for over one-third of exports - and a wide range of other manufactures. Manufacturing occupies about one-fifth of the labour force and provides about one-quarter of Gross Domestic Product. There is a substantial service industries sector which absorbs about 50% of the employed labour force (Economists, 1987).

Britain's visible trade turnover totalled £180,871 million ($325,568 million) in 1988 with a trade deficit of £20,557 million ($37,003 million) (Britain 1990). The volume of Britain trade is more than three times China's trade volume.

China's land is 39 times the area of Britain. And its population is 19 times the British population (**Table 2.1**). However, under the economic measure, the Gross Domestic Product (GDP) of Britain is 1.5 times the GDP of China. Furthermore, in terms of National Income Per Person, Britain is 26.5 times China (**Table 2.1 and 2.2**).

In terms of national income per capita, the UK belongs to the top thirty of the most developed industrial countries in the world, while China is classified as a third world developing country, ranking the 176th in the world.

By analysing the labour composition and production composition of the two countries (**Table 2.3**), we could find that in the Chinese economy agriculture is the dominant sector with industry at the second place. In the UK, service is the most dominant sector with industry in the second place. It reflects that Britain has entered the post-industrial era, while China is still in its pre-industrial phase.

Although it is still poor, China has been outstandingly successful in reducing extreme poverty. Although there is substantial income inequality between urban and rural areas and among different rural localities, the huger, disease, high birth and infant death rates,

Table 2.1 The World Gross Domestic Product, Population and Labour Force (Economist, 1987 & 1986)

	Gross Domestic Product			Population			Labour Force		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
World		12,820,000	2.0		4,820,000	1.7		1,670,000	41
China	9	310,000	9.6*	1	1,040,600	1.3	1	400,000	47
India	11	186,000	5.5	2	750,900	2.5	2	180,373	33
Japan	2	1,325,430	3.9	6	120,754	0.7	5	53,780	48
U. K.	6	455,622	1.9	14	56,618	0.1	9	26,258	47
U.S.A	1	3,947,000	2.4	4	239,283	1.0	4	96,917	45

(1) Rank by GDP in 1985
(2) GDP (in $ mn) in 1985
(3) GDP Growth Rate (% p.a.) for 1980 - 1985
(4) Rank by Population in 1985
(5) People (in thousand) in 1985
(6) Population Growth Rate (% p.a.) for 1980 - 1985
(7) Rank by Labour Force in 1976
(8) Labour Force (in thousand) in 1976
(9) Percentage of total Population in 1976

* China's GDP growth rate for the period of 1978-1988 (Peoples' Daily, 9 Jan. 1990).

Table 2.2 The World Standard of living (National Income per person ($) in 1985) (Economist,1987)

	Rank	Income per person ($)
World		2,380
China	176	270
India	188	226
Japan	18	9,452
U. K.	33	7,156
U.S.A	2	14,565

Table 2.3 Structure of Employment and Production in China and U. K. Data in 1984, (Economist,1987)

	Percentage of Employees			Percentage of Production (GDP)		
	Agr.	Indus.	Services	Agr.	Indus.	Services
China	61*	25*	11*	45	42	13
U. K.	2	34	51	2	49	49

* Data in 1986, Source from "The Far East & Austrilasia 1990" (Far East,1989)

general illiteracy, and constant fear of destitution and starvation that haunt very poor people in other countries have been more or less banished. Partly due to that, Chinese people usually live longer than people in other developing countries. In terms of expectation of life, China (69 years) is above the world average 63 years and middle-income country (62 years) and ranks the 43rd in the world. (*People's Daily*, 5 Jan., 1990)

Furthermore, the economic growth of China in the last forty years is quite encouraging. From 1952 to 1982, despite relatively rapid population growth and periods of acute economic mismanagement, per capita national income grew at an average annual rate of 4.0 per cent, with phases of significantly faster growth. Of particular relevance is China's performance during the last decade of economic reform: from 1979 to 1984 per capita national income grew at 6.8 per cent per year (World Bank, 1985). From 1986 to 1990, per capita national income grew at an average annual rate of 4.1% (People's Daily, 14 March, 1991).

In terms of average annual growth rate of GDP, China has maintained a relatively high record in the world for the last forty years- 6.1% for 1953-1978, 9.6% for 1978-1988 and 7.5% for 1986-1990 (Peoples' Daily, 5 Jan. 1990 and 30 Nov. 1990); while the world average was only 3.9% for the period of 1971-1980 and 2.9% for 1981-1990 (UN World Economic Survey 1989/1990).

It is now exactly ten years since the Chinese economy began a process of profound reform and re-orientation. The record of China's first decade was mixed. Accomplishments were sizable and obvious- a surge of production, a rise in living standards, and an explosion in foreign trade.

During 1979-1988, the export increased at an average annual rate of 15.4% while the import at 16.5% (Hartland-Thunberg, 1990).

During 1986-1990, the inflow of foreign capital was $46 billion. The annual inflow in the last five years is twice the annual figure in the first five years of the 1980s. (People's Daily, 14 March, 1991)

However, it must be noticed that since 1985, the Chinese economy has experienced severe problems of economic control, especially control of investment. The balance of payment has become a problem, foreign borrowing has accelerated, and foreign investment has been much lower than desired. The crisis was recognized by the authorities by the end of 1988 when its principal indicator- the inflation rate- has risen by 27% throughout the year. That was the worst figure for the last ten years (Howe, 1989).

From 1981, the British economy has grown at an annual average rate of 3% which is just above the world average rate for that period. Investment, export volume, the number of jobs and productivity have all risen substantially. However, after falling sharply in the early 1980s, the rate of inflation has risen since early 1988. By the August 1990, it was 10.6% at an annual rate. The current account of the balance of payment has been in deficit since 1986, following six successful years of surplus (Britain 1991).

The economic performance in UK and China for the period of 1978-1989 may be reflected from the index of inflation rate (Appendix 2.2).

2.2 A Brief Historic Study of Information Communication

Information communication in human society has a long history of several thousand years. **Table 2.4** gives an approximate time chart with the emphasis on UK developments since 1500 in the left column and developments in China in the right column. (Vickery, 1987 and Infor. China, 1989)

Ancient Chinese people contributed a lot to the civilization of the world. The invention of paper and printing have made printed materials the most important medium for the storage and transfer of information for more than five centuries. Even in today's computer era, printed materials still remains one of the most important information media.

The Renaissance in Europe in the 14th and 15th centuries was a prelude to the industrialization and modern science and technology. However, China's development during that period still remained within the thousand year old feudal frame which sought to limit the Western influence. As shown in Table 2.4 from 1250 until the middle of 1800s, most innovations were made in the West rather than in China.

The 1840 Opium War between China and Britain shook and at last destroyed the thousand year old Chinese feudal society. With the downfall of the last dynasty - Qing in 1911, China set off on the journey of industrialization and modernization, somewhat three or four hundred years later than the advanced countries. Since then, the Western sciences and technologies (S&T) have been gradually introduced into China. Ever since, the gap in S&T between China and the advanced countries has been reduced. The modernization trend has been greatly accelerated since 1949 when the Peoples Republic of China was born.

Table 2.4 An Approximate Time Chart
Source from (Vickery, 1987) and (Infor. China, 1989)

Year	Events in the World*	Events in China
-3500BC		Inscriptions on animal bones and tortoise shells
-3000	Writing:clay tablets, papyrus rolls Temple and palace archives	
-2000	Horse transport Alphabet	
-1000	clay tablets in Assyria	Documents written on bamboo slip silk Royal and Private libraries
-500	Official couriers in Persia Scholarly libraries (e.g. Alexandria Museum) Parchment roll, manuscript trade private libraries in Rome	Postal delivery stations
0	Roman roads facilitate transport 'Public' libraries, *Acta diurna* in Rome Encyclopedias Codex book	Paper invention *Qi Lue* - Chinese first classified bibliography
500AD	Monasteries and scriptoria	Block printing invention The first newspaper- Chinese Court Paper
1000	Spread of papermaking Cathedrals and their libraries	movable type invention
1250	Universities, manuscript trade Humanist scholars Commercial couriers Printed book	Postal delivery route throughout China and connected with Europe and Asia Private and official publishing houses
1500	Bibliographies Pamphlets, patents, newsletters State archives Legal and medical libraries	
1600	Royal libraries Town libraries Postal service Royal Society of London Scientific Periodicals	*Si Ku Quan Shu* - the biggest national bibliography (comprising 3,503 title books of 36,300 volumes or parts)
1700	Newspapers Circulating and subscription libraries Agricultural and other societies National libraries (e.g. British Museum) Roads and Canal, mail coaches	

continued

1800	Trades unions Abstracts journals, annual reviews Lithography Parliamentary reform Steamships, railway Government libraries Public Record Office Photography Telegraph	Modern newspapers and Periodicals, most published by foreign residents
1850	Public Libraries Act News agencies Professional societies Microfilm Rotary printing press Education Act Telephone, typewriter Parliamentary reform Civic universities Major library classifications Punched records Disc audio records Linotype, Monotype	Cables, telephone in a small scale Modern colleges and universities First big group of Chinese students (120 people) sent abroad (USA) by government for study
1900	International associations Office duplicators Cine films Industrial research Aircraft Photostat Women's franchise Radio broadcasts Interlending, special libraries Facsimile transmission Tape records Television Broadcasts Information centres Technical reports Phototypesetting Xerography Education Act UNESCO	The Qing government founded the first public library in 1904 The first Chinese news agency in Guangzhou (Canton) in 1904 Radio first used in China (1905) Radio broadcasting in SHANGHAI in 1922
1950	Digital computer New Universities and polytechnics British Library Communication satellites Timesharing computers Computer typesetting Databases, databanks Computer networks Videotapes Microprocessors Video discs Expert systems	TV broadcasting Institute of S&T infor. of China (ISTIC) Chinese abstracting journals library automation in small scale communication satellite 60 international online terminals wide application of PC and microcomputer computer aided secondary publication S&T numerical and fact databases S&T bibliographic databases China Patent Office and Patent Law

*After 1500, the emphasis in the left column is on the developments in U.K.

Modern newspaper and periodical first appeared in China in the late 19th century which was somewhat one hundred year later than in the West. However, the radio and TV broadcasting appeared respectively just twenty years later in China than in the West. China commenced its first experiment on computer in the mid 1950s which was only ten year later than the West. In 1970, China launched its first satellite, and today it is among a handful of nations in the world that hold this high technology.

In the developed western countries in the 20th century, developments in scientific and industrial research, with a consequent vast increase in the publication, on a world-wide basis, of specialized information - have led to a demand for rapid and easy access to a wide range of periodical literature and information services that could furnish references and bibliographies on specific subjects.

One of the most significant features in the century is the growth and blossoming of special libraries, often connected with commercial enterprises or specialized professional bodies and financed by them. The studies in Chapter 7 will show the heavy investment in information work by the UK pharmaceutical industry.

In the early 20th century, library reference services, interlibrary cooperation (e.g. interlending, acquisition cooperation, national union catalogue, etc.), photocopying and microphotographs had become common in the USA and Europe.

Another major feature of the century is information centres. While libraries, as a matter of both economic necessity and basic philosophy, attempted to guide the reader to the materials he desired without influencing his own evaluation of them, information centres undertake to analyse, evaluate, select, and even on occasion to synthesize answers to questions by users. In Chapter 7, some kinds of information centres in the UK pharmaceutical information flow, such as business information specialists, drug information centres, etc. will be studied.

One of the most significant achievements is the wide spread of library automation during a relatively short period in the 1980s. Furthermore, Information Technology (IT) during the last thirty years has made significant changes in the storage and retrieval of information.

During the 1960s, computer typesetting methods began to be introduced for the production of printed publications. Specially, these methods were applied to the production of secondary publications: abstracting and indexing journals, etc.

As a by-product of the typesetting magnetic tapes became available containing computer-processable versions of the text/data in the secondary publications. It was then possible to search this text/data satisfying certain criteria. Initially such information retrieval was carried out *off line* : the questions were submitted to computer centre by hand or by post.

Gradually, with improvements in both computer and telecommunication technology *Online* information retrieval became possible. Special organizations were created that regularly acquired each magnetic tape of text/data as it became available from several different publishers; these organizations then added this text/data to the "database" already stored on their own large computer. These host organizations (later known as " the hosts") then provided increasingly sophisticated database searching facilities to anyone with a suitable computer terminal and access to the telecommunications facilities needed to link the terminal with the host computer. One host could provide access in this way to several databases acquired from different publishers, each being searchable with the same information retrieval computer programs.

Since the mid 1980s, optical storage technology has been rapidly emerging as a noteworthy factor in recording and distribution of information. CD-ROM is the latest technology to capture the imagination of information professionals. It is now not only possible but economically viable to store an entire database such as EI, Medline, SCI etc. on a single 13cm compact disc. Vast stores of information, which previously could only be searched using mainframe machines, can now be searched and manipulated conveniently and effectively using a personal computer.

By the end of the 19th century, China seemed to be backward almost in every field of science and technology, including information services and technologies. Since the 1949, however the world has seen China's relatively rapid development in its current S&T history.

In the 1950s, the national infrastructure of libraries and scientific and technical information institutes was planned and built up. The Institute of Scientific and Technical Information of China (ISTIC) began to compile national abstracting and indexing journals for the first time in China. The use of microform and photocopy machines became popular in more and more big libraries.

From the middle of the 1970s, Chinese scientists started experiments on computerized information storage and retrieval as well as library automation.

Since the early 1980s, more than sixty online retrieval terminals have been installed in 27 Chinese cities, which enable Chinese users to search hundreds of S&T databases through 8 major international hosts (such as DIALOG, ESA-IRS, STN etc.). Apart from online searching, China has also imported 52 S&T databases on tape on which a few big information organizations and libraries run the "off line" information retrieval services (Zhou, 1987). Generally speaking, the application of computers both in accessing international databases and in processing domestic documents are still in the beginning stages in China, partly owing to the inability to spread computer application in library and information organization, partly because of the lack of effective tele-communication networks.

In China now there is a mixture of various levels of information technology: from the 1980s' technology of online and CD-ROM searching, to the 1970s' offline information retrieval; from manual abstracting and indexing services to computer aided abstracting and indexing services. The imbalance in IT application between big libraries or information organizations and small ones, between developed regions and underdeveloped regions is serious. A more detailed description is given in §2.3.3.

2.3 Current Communication Environments in Britain and China

This section takes us to the following environmental sectors of information communication- mass media, transportation and information technology (IT).

Since cities are distinctive and important in information generation, dissemination and communication in comparison with other forms of social organization, we will give more attention to the urban environment than the rural in the two countries. The UK is an urban country, three quarter of the population living in urban areas. (Rose, 1982) China is a rural country with seventy to eighty percent of the population living in rural areas. On the other hand, however, China has a huge number of urban residents. A steady but rapid move from rural to urban has been seen especially since 1949. In 1949, there were 69 cities[1] including 16 with a population exceeding 500,000. By the end of 1990, however, the number of cities had grown to 461, with a population of 331,857,000

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1 Chinese cities are divided into three tiers: centrally administered cities which enjoy the same status as provincial and autonomous regional governments (at present there are three such cities Beijing, Shanghai and Tianjin); cities under the direct administration of provincial or autonomous regional governments, which enjoy the same status as prefectures; and county level cities under the administration of prefectures which have the same status as counties (Infor China, 1989).

(almost 6 times of the UK total population). Of them there were 98 cities with more than 1 million people, 153 cities with more than 0.5 million people. (People's Daily, 14 March 1991)

2.3.1 Mass Media

Periodicals

The terms " periodicals " and " serial " include newspapers, magazines, trade journals, and annual reports, as well as learned or scholarly journals. Willings Press Guide for 1991 lists 8904 UK periodicals and 1654 annuals.

China's figure in 1985 was 4,705 journals and magazines and 2,191 newspapers (Infor. China, 1989). The difference in number of periodicals between the two countries is not very significant. However, if we consider the circulation among the population, the information deficiency in China will become astonishing. For example, **Table 2.5** shows that in the UK every 1000 people have 411 titles of newspapers whereas every 1000 Chinese people have only 29 titles.

Table 2.5 Newspaper Circulation in 1985 (number of copies per 1,000 people) (Economist, 1987)

	USA	U. K.	China	India
Rank	23	10	99	106
Number	267	411	29	21

Radio and Television

In China, although radio and TV broadcasting were started respectively in 1922 and 1958, the former were not popular until 1960s, while the latter not until 1980s. **Table 2.6** gives the radio and TV sets ownership in four selected countries.

Table 2.6 Radio and TV Sets Ownership in 1985 (number per 1,000 people) (Economist, 1987)

	Radio		elevision	
	Rank	Number	Rank	Number
World		310		135
U.S.A.	1	2030	1	785
U. K.	8	993	25	328
China	172	68	134	6.8
India	178	55	146	3.8

The above figures of periodical circulation and radio or TV sets ownership could show general information deficiency in China. However, on the other hand, one may argue that because of the nature of mass media and the dense population in China urban area and cultivable area (it is estimated about eighty percent of China's population are concentrated in one fifth of its land; see Appendix 2.1), mass media could be more effective in China than in other countries with low dense population.

In the UK apart from the four national channels of BBC radio, there are over 40 local radio stations and four television channels. It is estimated that about 42 million (74% of population) people watch TV each day and 25 million (44% of population) listen to the radio (Vickery, 1987).

In China, the central government supervises and administers broadcasting throughout the country. Directly under its control are the Central People's Broadcasting Station (CPBS) and the China International Broadcasting Station (CIBS), China Central Television (CCTV). Most of big cities have their own radio and TV broadcasting stations. In China now there are 204 TV broadcasting stations, 507 TV transmitting and relay stations, 215 radio broadcasting stations and 575 radio transmitting and relay stations. According to the official estimate, by 1990, radio will have reached about 80% of the population and television 75% (Infor. China, 1989).

2.3.2 Transportation

Here we should put some emphasis on the transport situation in China comparing to the UK, because today getting documents from one place to another still has to mainly depend on transportation (particularly ground transport), and people need to travel to communicate with others under certain circumstances. **Table 2.7** is a comparison of transportation in the UK and China.

Table 2.7 Transportation in China and UK

Source from
Far East and Australia 1990; Britain 1990; Jane's World Railaways 1989-1990 (Allen,1989); *British Airway Annual Report 1987-1988; and British Waterway Board Annual Report 1987-1988*

		China(1984 or 1988)*		Britain (1988)	
Length (10^3 km)	Rail: total	51		16.6	
	electrified	3		4.46	
	Road: total	1,500		378	
	motorway	0		3	
	waterway	109		3.2	
Freight (10^6 ton-km)	Railway	978,600	43%	18,103	12.5%
	Road	287,100	13%	108,600	75.4%
	Waterway	996,400	44%	60	/
	Air	740	/	17,225	12%
Passenger-km (10^6)	Railway	326,000	54%	34,321	8.3%
	Road	238,200	39%	332,500**	80%
	Waterway	20,400	3%	/	/
	Air	21,400	4%	49,123	11.7%

* the Chinese length data in 1984
the Chinese freight and passenger data in 1988

** No British road passenger-km data available.
the data above is the British vehicle-km (million).

Although China is 39 times the UK in area, 19 times the UK in population, its GDP is only 68% of the British figure. The weakness in its transportation is one of the major blames for the economic backwardness. Its railway length is too short to cover its vast land - only 3 times the British railway mileage.

Although its road length is 5 times the British, its road haulage and passenger-km are respectively only 2.6 times and 20% of the British figures, because of the relatively poor road conditions.

Engineering expertise is lacking in connection with trunk motorway traffic, railway electrification and aviation. The ratio of railway electrification is 5.9% in China in comparison with 27% in the UK.

In the UK, although motorways and trunk roads account for 4% of road mileage, they carry 34% of road traffic , including nearly 61% of heavy goods vehicle traffic. In China by the end of 1980s there has not yet been any motorways in use, though several joint ventures on motorway building have been signed since the late 1980s.

In the UK, road haulage has a dominant position in the movement of inland freight, accounting for about 75% of tonne-km. Railways, inland waterways and other transport are important in carrying certain types of freight. On the contrast, in China, lorries and buses are regarded as constituting merely a supplement to rail and water-bone transport, respectively accounting for 12.7% of tonne-km and 39.3% of passenger-km (Table 2.7).

The whole Chinese transport system is very inadequate in general and for the need of the energy sector in particular. To take the example of railway, relentlessly rising demand for passenger and freight transportation outstrips both railway infrastructure and rolling stock capacity. Passenger traffic has quadrupled since 1960, whereas the number of train run has risen by only 1.7%. Consequently severe overcrowding is common, inability to buy a ticket likewise in some major cities. Freight tonnage was rising by a similar ratio during that period. Here too, shortage of capacity had led to inability to supply raw materials to some manufacturing plants, driving them to temporally closure (Allen, 1989).

There are the same difficulties in road, waterway and air transport in China. Inevitably, these weakness in transport sector have long been disturbing normal travelling and made nationwide documents interlending in fact impossible.

2.3.3 Information Technology

I. World IT situation

Each year the information technology industry trade press reports on the size of the industry. It is reported that between 1980 and 1989, sales of PCs increased more than **30 fold,** from fewer than half a million US dollars to more than 15 million (according to *PC Week,* Dec 25 1989 p10); the number of databases grew **10 fold,** from 400 to just over 4000 (according to **Cuadra's Directory of Online Databases 1991;** see **Table 2.8**); at the same time, the use of databases in the information centre/library market as measured by the number of online searches grew **6 fold,** from 5 million to 32 million (according to Williams as reported to the *Wall Street Journal,* April 3, 1990).

Table 2.8 The Growth of Online Databases in the World
(Cuadra's Directory of Online Databases 1991)

year	No. of databases	No. of producers	No. of hosts
1979/1980	400	221	59
1980/1981	600	340	93
1981/1982	965	512	170
1982/1983	1350	718	213
1983/1984	1878	927	272
1984/1985	2453	1189	362
1986	2901	1379	454
1987	3369	1568	528
1988	3699	1685	555
1989	4062	1813	600
1990	4465	1950	645
1991	4869	2120	718

During the 1980s the world has seen the online industry developing into mature status. In the early 1980s, there were a small market confined almost entirely to research and library users; databases then were predominantly S&T; databases were almost wholly bibliographic; most users of online databases accessed the systems from "dumb" terminals.

By the end of the 1980s, the picture has changed significantly. There is a large world-wide market for business databases. S&T databases comprise a very small percentage of total revenues of online industry - less than 10% of revenues are from S&T databases whereas other 90% are from business databases (Fischer, 1990). The present world online database revenues is $4 billion (According to Information Hotline, Vol 22 No.2, Feb.,1990); while in Europe alone, the market for business information databases is estimated at £1 billion (or $1.8 billion) (Online Business Source book 1990).

Bibliographic databases comprise a small percentage of total revenues of online industry. Furthermore, numeric databases are likely to experience more rapid growth than either bibliographic or full text databases in the 1990s. A report estimates that bibliographic databases will decline from the present **third** of total offerings to about a **quarter** by 1994. Numeric databases will grow from **36.6%** presently to **41.5%** in the same period, and full text databases will grow only marginally from **29.6% to 31.9%** (According to Information Hotline, Vol 22 No.2, Feb.,1990).

The late 1980s has also seen the new generation of British and Europe-wide online databases starting to provide a rich alternative to US products. The European user market has grown rapidly in size (some 20% per year) and sophistication (Online Business Source book 1990).

In the last few years of the 1980s, CD-ROM as a new generation of information storage and retrieval medium has made a great impact on IT market. The CD-ROM Directory 1990 the 4th edition published by TEPL, provides information on 816 CD-ROM products (mostly US made) comparing to only 390 a year ago.

II. UK

In 1989, Aslib conducted a survey into the use of information technology by information services of its UK membership (Ramsden, 1990). Total 373 questionnaire forms were returned from 1853 sent out.

About 96% of respondents reported using some form of IT, reflecting high application rate of IT. That 37% of IT users had started using IT in the last two years suggests rapid movement among information services from non-user of IT towards user of IT. About 91.5% of respondents reported using computers. Of them, 22% use mainframe, 44% minicomputer, 94% micro-computer.

About 24.6% of respondents stated that they were using some form of optical disk drive. This is a massive increase when compared with 1% in 1986. About 93% of optical drive users had CD-ROM .

About 63% of respondents were using some type of microform reader/printer.

About 82% of respondents were using online retrieval systems, an increase of 8% since 1986. And 8% of respondents stated that they planned to start using online systems in the next two years.

The survey also shows a drop in the literature searching user proportion of online users (from 99% in 1986 to 90% in 1989) and an increase in fact retrieval user proportion of online users (from 64% in 1986 to 70% in 1989); reflecting the growing number and use of business databases.

Generally information users in industry especially in the pharmaceutical industry use online much more than users in academic or public sector.

A survey on UK academic institutions and public libraries market for online service was currently carried out during 1987-1988 (East, 1990). It was reported that in 1988, the average annual online expenditure was £4,000 per service among public libraries, £6,700 per service among polytechnic libraries, and £9,600 per services among university libraries.

According to the estimate of the survey, the total annual expenditure in online service by all UK academic institutions and public libraries (some 160 at present) is between **£1.7-5.2 million per year** by the end of the 1980s.

A survey on UK pharmaceutical companies shows that in the mid 1980s, the average online expenditure in a large company was over **£100,000 per year**; the expenditure was **£10,000-20,000** per year in a medium sized company; the expenditure was a few thousand pounds per year in a small company (Clark, 1985).

For example, in Pfizer Central Research UK, the online searching volume and expenditure have grown greatly from 131 searches and £7,000 in 1976/7 to 1163 searches and £66,000 in 1984/5 (Bawden, 1989). The online expenditure in Pfizer is seven times the average figure in academic libraries.

In a medium sized university library *Pilkington Library* in Loughborough University, the annual volume of online searching in 1990/1991 was 363 searches (the last year figure was 290 searches), and about £16,000 (data from the Information Officer in the Pilkington Library). Although the online volume in this library is higher than the average figure in UK university libraries, it is only one third of the volume in a middle sized pharmaceutical company in UK (Pfizer UK).

III. China

Despite of the rapid progress since 1949, telecommunication are generally in short supply. The telecommunication network, except TV and radio broadcasting, cannot reach the remote areas. At present, telephones are available in cities, townships and half of the villages. An average of 0.6% of the population have phones, a ratio of 200 people per phone, which is lower than the world average of 13% as well as lower than the UK figure of 52% (Economist, 1987). Even the residents in big cities, like Beijing, find it difficult to make a local call and the situation is even worse in respect of long-distance call when there is no direct-dial long-distance phone system existing.

As far as the capacity of telecommunication channels is concerned, the British Telecom has about 610,000 km. of optical fibre laid in its network in Britain. The combination of digital exchange switching and digital transmission techniques, using optical fibre cable and microwave links, is substantially improving the quality of all telecom services (Britain 1990).

In China, digital transmission using optical fibre cables is still at trial stage. Only local telephone communication systems have applied microwave links. Long distance telecommunication are mainly transmitted by open wire with the supplement of underground low speed transmit cables. By 1985, China has built up 179,000 km. of underground long distance cables which are only one third of the British optical fibre cable length even without mentioning the significant difference in the transmission speed between optical fibre cable and non-optical fibre one (Infor. China, 1989). These underground cables in use in China only have up to 4,380 Channels of capacity, whereas optical fibre cables in use in the UK has already reached the capacity of 10^7 channels (Infor. China, 1989 & Vickery, 1987).

Relatively China has a small computer industry compared with the developed nations in the world. In 1984, China had an annual production of 400 sets of large, medium and small computers and about 30,000 micro-computers (Tang, 1984). Although its annual micro-computer production has risen to 100,000 by 1989 (People's Daily, 29 May 1990), it is still far from meeting the domestic market demands. Each year, China has to use some of its very limited hard currency to import a certain amount of computers. As a result, total number of computers in the country is very small.

According to an ISTIC survey (1985) on 3888 scientific and technical information services and libraries in 1985, only 25% of information services using computers. The growth in IT application has been very slow since then, because of lack of funds (White Paper, 1990 & Academia Sinica, 1991).

Of the very small group of computer users, only 0.25% have mainframes, only 6% were using minicomputers while the other 94% were using micro-computer.

Compared with the Aslib survey in UK (22% using mainframes, 44% using mini-computers, 94% using micro-computers), it is quite clear that the application of computer is at a very low level in China.

During the 1980s, China has imported about 52 foreign bibliographic databases with a total 30,000,000 records. One example is the Medlars centre in the Chinese Academy of Medical Science (1987-). The Chinese Medlars centre has a IBM-4361 computer which stores the MEDLINE database (1966-) in tapes. There are 5.5 million records since 1966 with an annual input of 400,000 new records. During the first one and half year of the operation of Chinese Medlars, it has conducted 2500 searches for 600 users and built up 500 SDI profiles for 100 users nationwide.

By the end of 1989, there are 262 domestic S&T databases - half are bibliographic and half are numeric or factual. Among them only 60 have more than 5000 records.

All these imported or domestic S&T databases are mainly providing inhouse searches. Only few large databases such as Medlars in Chinese Academy of Medical Sciences could provide offline searches to external users.

By the end of 1989, 60 information organizations in 27 Chinese cities have installed international online terminals connecting through satellite with a few large hosts such as DIALOG, STN, ISA-IRS, etc..

Only **1.5%** of Chinese information services have direct access to international online databases. Less than **1%** of Chinese information services have imported foreign databases in tape and built up inhouse retrieval system on them. Less than **6%** of Chinese information services have built up domestic S&T databases and provided inhouse searches to users. By comparison, 76% (in 1986) and **82%** (in 1989) of UK information services have been using online systems.

In 1988, China has made 20931 *international online searches (31%* of total searches in China), 37,108 *inhouse domestic database searches (55%* of total) and 9026 *inter-organization searches (13%* of total) within the country (Academia Sinica, 1991).

The annual volume of 20,931 international online searches made in China accounts for only 0.1% of 32 million searches in the world. The total number of online searching in China is only 4 times the volume of a UK pharmaceutical company Glaxo (about 5,000 searches per year, see Chapter 7).

The biggest online searching centre of total 60 in China is at ISTIC in Beijing. Its annual online searching volume is three thousand searches which is less than the volume in Glaxo (about 5,000 searches per year). It was estimated that ISTIC annual online searching expenditure was $34,600 in 1986 accounting for about 15% of annual online expenditure (£128,800 or $241,049 exchange rate in 1987) in SRIS of British Library in 1986/1987 (BL 14th annual report 1986-87). The annual online expenditure at SRIS of BL in 1989/90 is £127,528 (or $204,746 exchange rate in 1989) (BL 17th annual report 1989-90).

Other 60 international online searching centres each has a volume of 200-300 searches per year (Zhou,1987). The annual online volume in one of these Chinese online centres equals to that in a medium sized academic library in UK (according to the Information Service statistics (1989 & 1990) at Pilkington Library, Loughborough University).

One expert estimated that today's annual volume of online searching in China equals to that in Europe in the early 1970s (Zhou, 1987).

Above all, due to the backwardness in computer and telecommunication technology, China is far from entering the "telematics stage".

2.4 Concluding Notes

Above all, the information environments in China and UK have experienced different evolution, are in different stages of development, on different socio-economic bases, and are bound to influence and affect pharmaceutical information flow quite differently in the two countries.

The mass media is relatively well developed in China compared with other two sectors "transportation" and "information technology". TV and radio have a coverage as high as that in developed countries. The backwardness in telecommunication has serious impacts on IT sector in China. One estimation is that today the annual online volume in China equals to that in Europe in the early 1970s. The shortage of computers is the major cause for low computer application in Chinese S&T information services such as domestic S&T information database etc.. The serious difficulties in road, rail, and other transportation are considered as one of major causes for lack of interlending networks in China.

The information environment in a country greatly depends on the national economic capacity. The environmental influences on pharmaceutical information flow in China and the UK will be explored in the final part of the thesis (Chapter 9).

There is no doubt that the current information environment in China is not so good as that in UK and other developed countries. To improve information environment needs sufficient financial support. China's limited economic capacity has prohibited a quick progress. In China now there is a plight of many sectors of activities competing for a very small amount of hard currency reserve. For example, the low application rate of computers in S&T information services is caused by limited domestic production and limited import of computers.

The powerful central government of China, however, could set priorities in development on the most important projects. There has been a rapid progress in China's telecommunication and road transportation for the last five years.

Telecommunication has become the most rapid developed field in China for the last five years by getting an investment which exceeded the total amount of previous 36 years.

As a result, the average telephone ownership by China's population has risen from 0.6% in 1985 to 1% in 1990. The number of cities with digital telephone exchange systems has risen from 20 in 1985 to 300 in 1990 (Infor. China, 1989 & People's Daily, 15 Dec. 1990).

Because of the increase in investment at road building, the proportion of higher standard road has been doubled in China for the last five years. The first modern motorway, although very short (only 500km., comparing to 3000 km. in UK) has been completed by 1990. It is estimated that for the past five years China's road transport capacity has been increased by 50% (Peoples' Daily, 1 Feb. 1991). To improve the Chinese information environment, the government still needs to stimulate the national computer industry to meet the great demands of domestic market.

Chapter 3 Medicines Research In Britain And China

Pharmaceutical information flow system exists within the special environment "national drug situation" and the wider system "national pharmaceutical industry". The mission of this information flow system is determined by its wider system and is influenced by its special environment. Chapter 3 describes the special information environment and the wider system. The great emphasis is on medicines research or pharmaceutical R&D - the most important feature of the modern pharmaceutical industry and drug situation. In this chapter, we will approach to the comparison along the following lines-

A. Drug situation and pharmaceutical industry in China and the UK,

B. Organization of medicines research in China and the UK,

C. Status of medicines research in China and the UK,

D. Size of medicines research in China and the UK.

3.1 Drug Situation and Pharmaceutical Industry in Britain and China

In 1977, the World Health Organization (WHO) published the first model list of ***essential drugs***. Since then a large number of countries have adopted an essential drug policy. The progress achieved in these countries have been reported in a document *"The World* Drug Situation" (WHO, 1988). Describing the world drug situation, this report overlooks on the broad aspects of *drug consumption, production, and trade*. We believe that such an approach will serve as a background to the study on pharmaceutical information flow in Britain and China. So in this first section of Chapter 3, the drug situation and the pharmaceutical industry in the two countries are to be addressed.

World Drug Situation and Pharmaceutical Industry

According to the WHO report, at present 75% of the world population living in developing countries consumed only 21% of the world's drugs. The twenty largest markets accounted for 80% of world consumption in 1985, among which there were only 8 developing countries who accounted for 64% of the drugs available in the developing world. Among the top 20 markets, China ranked at the 4th and UK at the seventh. However, as far as the huge population in China is concerned, the average drug consumption per head in China is much lower than in the UK.

In 1989, drug consumption in UK was 60 Pound whereas it was only 21 Yen (3.1 Pound) in China[2]. (See following sections about UK and China)

The patterns of drug consumption, production and trade are very different between the developed part and the underdeveloped part of the world. Developed countries include the western European countries, the north American countries and Japan.

Global pharmaceutical sales are expected to reach $140 billion in 1991, at wholesaler selling prices, excluding the communist world and Eastern Europe. The three major trading blocs, the US, Japan and Europe account for **30%, 20% and 30%** of the total market respectively. The top three markets, in order, are the US, Japan, and Germany (*Scrip*, Sept. 18th, 1991 No. 1652).

The uneven distribution of world drug consumption is associated with uneven distribution of drug production which concentrated in seven developed countries throughout the 1980s - USA, Japan, West Germany, France, UK, Italy and Switzerland. The analysis suggests that British inventions accounted for **31%** of the estimated £95 billion world-wide prescription drug sales in 1989, with the US accounting for **42%**, the rest Europe **19%** and Japan **8%** (ABPI Pharm. Facts and Figures, 1990).

There are 3 types of pharmaceutical companies. First type is the ethical drug company whose products are the result of **R&D**, are **patent protected** and are available on **prescription only**. The second type is generic drug company. They produce off patent prescription products and hence have no research and only limited product development expenditure. The third type provides non prescription over the counter (OTC) medicines. Some companies have divisions which operate in both the ethical and OTC markets and a few also have generic divisions. However, the bulk of the pharmaceutical market in revenues is made up of ethical products.

Although the pharmaceutical industry comprises **10,000** companies world-wide, no more than **100** companies, the large R&D oriented firms, have a significant share of the international market, and over the years, they have tended to remain the market leaders, only their rank shifting. Chinese pharmaceutical manufacturers mainly supply the domestic market and export bulk pharmaceuticals (intermediates) and TCM raw material with no participation in world ethical drug market (WHO, 1988). Accordingly this thesis

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2 In fact, the above figures are not so valid for direct comparison because that the drug price in China is much lower than the drug prices in many other countries. It is reported that the price of medicines in China is only 10% of that charged in the West. (Scrip, Sept. 18th 1991, No. 1652) concentrates on **the ethical pharmaceutical industry in UK** comparing to a different type of **pharmaceutical industry in China where there is no patent protection and is little R&D**.

For many years, the ethical pharmaceutical industry has been in the unique position in most developed countries of having customers (physicians) who are neither responsible for paying for their products (funded by government) or consuming them. The world healthcare market has been growing since the World War II. Also the industry has been protected form competition from non branded substitutes by legislation introduced in the 1950s. Hence the pharmaceutical industry in the West has sustained profitable growth for the past 50 years.

By the end of the 1980s, however, it seems that the R&D based pharmaceutical industry has been faced with some challenges. Increasing generic prescribing (as governments try to contain rapidly rising healthcare costs), coupled with the escalating cost of R&D and diminishing returns in terms of NCEs reaching the market, are central to the industry's case for longer patent life, a relaxation of pricing controls and faster US and Europe approvals.

***China*[3]**

The main objectives of the Chinese pharmaceutical industry have been to meet the priority needs of the population through local production and to develop the country's export potential. Major problems encountered are related to the need to improve quality control, to increase research and to strengthen international marketing capacity. Today, China is 90% self sufficient in drug consumption. In the 1950s, priority in production was given to bulk antibiotics, sulphonamides, antipyretics, vitamins and drugs for endemic diseases and tuberculosis. In the 1960s and 1970s, production was expanded to include steroids, anticancer agents, drugs for cardiovascular diseases, products for upper respiratory tract infections and asthma etc..

Currently there are about two thousand pharmaceutical manufacturers or factories in China, of which about 900 produce western medicines (WM)- bulk pharmaceuticals and western medicine finished products; about 500 produce TCM brand products (TCM standing for Traditional Chinese Medicines).

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3 Data and facts in this section are from China Pharmaceutical Yearbook 1987, and SPAC 1989 Booklet, unless otherwise indicated.

In pharmaceutical chemical production sector, China now is able to produce 24 therapeutic categories of medicines, 3500 finished products and 1300 different bulk pharmaceuticals.

In TCM production sector, China is able to produce 4000 brand products using 40 different dosage forms.

Since 1978, great growth in Chinese pharmaceutical industrial production has been achieved. The average annual growth rate of industrial output in value has exceeded 10% for the last 12 years.

In 1987, the gross value of industrial output (including bulk pharmaceuticals, WM finished products, TCM raw materials and TCM brand products) amounted to ¥21 billion whereas the domestic sales added to ¥18 billion, accounting for 86% of the industry's gross output. The industrial output ratio of chemical pharmaceuticals (bulk and finished products), TCM raw material and TCM brand products was 15 : 2 : 4.

Importation of drugs is regulated by law and restricted to small quantities. China is a major international supplier of pharmaceutical chemicals and also one of the largest producers of antibiotics, vitamins, and sulphonamides. In the 1980s, it annually exports approximately 40% by weight (23 million kg) of all bulk pharmaceutical chemicals produced. This however accounts for only 7% of the *yuan* value of annual sales, because of the low price of bulk pharmaceutical in the world market (WHO, 1988).

In 1986, exports of pharmaceuticals and TCM were worth $600 million, an increase of 17% over 1985 whereas in 1985 the increase was 11.5% over 1984. TCM herbals accounts for approximately 60% of exports whereas bulk pharmaceuticals for 40% (i.e. **$240 million**). Overall, China has a strong favourable trade balance for health care products, of $200-300 million a year. Major imported products are S&T instrument and production machines (WHO, 1988).

The pharmaceutical (bulk pharmaceuticals) export by China has risen from $240 million in 1985 to $400 million in 1987. The export capacity of the Chinese pharmaceutical industry (WM) (**$400 million** or **¥1.5 billion** in 1987, for exchange rate see Appendix 2.3) accounts for about **10%** of the industry gross output (**¥15.6 billion** for the pharmaceutical industry (WM) in 1987).

The economic reform (1978-) has expanded the sector of transnational pharmaceutical production in China. A number of joint venture contracts have been completed. First two had started production in 1986. Since then, there have been several dozen new joint ventures adding in. The world pharmaceutical industry newsletter *Scrip* of PJB has been monitoring the progress of joint ventures in China (see Chapter 7).

There is no doubt that the Chinese population has benefited from the boom in pharmaceutical production and now has access to a much wider range of drugs including sophisticated drugs. As having been reported above, the drug consumption per capita has almost doubled during the four year period (1985-1988), from ¥11.53 to ¥21.06 (China Medicines Economic News, No. 39 Oct. 1 1989).

There are two types of medicines co-existing in China at present, traditional Chinese medicines (TCM) and Western medicines (WM). Generally, TCM is the major source of care for most peasants in rural areas today. However, WM is more popular in urban areas. Doctors, institutions and hospital beds of WM strikingly out-number doctors, institutions and hospital beds of TCM. A current survey shows that in 1985 there were **92** WM universities with **128,937** students enrolled while there were only **24** TCM universities with 28,450 students enrolled. In China in 1985, there were 336,224 TCM doctors accounting for only **2%** of total 1,413,000 doctors in China; there were 1,485 TCM county and large hospitals accounting for only **2.5%** of total 59,614 county and large hospitals in China (Shao, 1988).

Eighty percent of people in China live in the countryside. Before 1949, health services were almost unavailable for rural people. Since 1949, the national health care system (see Fig 3.5 in §3.2) has been built up which met the basic medical needs of peasants. Compared with urban areas, differentials still exists: in 1985, there were only 0.32 senior doctors and 1.53 hospital beds per 1,000 population in rural areas, whereas there were 2.15 senior doctors and 4.54 hospital beds per 1000 population in urban areas. The average per capita health expenditure is about ¥47.37 in the urban areas whereas it is only ¥11.30 in the rural areas (Shao, 1988).

In 1985, the domestic drug sales was between ¥12-14 billion[4], of which 40% went to the TCM sales (brands and herbals). About 32% of the domestic sale goes to the rural areas while 68% of the total goes to the urban areas, though about 80% of population is in rural areas (Green Book, 1988). About 90% in value of all medical supply are

4 ¥12 billion (Green Book, 1988); ¥14 billion (WHO, 1988).

supplied by wholesalers to hospitals and less than 10% are sold through retail units (WHO, 1988). At the manufacturers' prices, the China market for pharmaceuticals was between ¥12-14 billion in 1985, equivalent to an average spend of ¥11.53 per head. This represents about **1.6% of GDP** (Green Book, 1988). The estimated total health care expenditure in China in 1985 was ¥24.5 billion which accounts for **3.2% of GDP** (Shao, 1988). So the cost of medicines is as high as **60%** of the total amount spent on health care in China which is much higher than the ratio of **10%** held for the past thirty years in UK and other developed countries (Scrip, Sept. 18th 1991, No. 1652). This may reflect the difference in the society's valuation of the role of medicines in providing good health between China and the developed countries.

According to the WHO evaluation in 1988, among the three groups of total 104 developing countries, China belongs to the highest grade *Group C* - the 47 countries with high medicine coverage.

The situation in China is assessed as follows:

1. 60-90% of the population have regular access to essential drugs;

2. has a national pharmaceutical policy;

3. has a drug regulatory administration but which is not fully functioning;

4. a quality assurance system including a quality control laboratory exists, but does not function adequately;

5. the provision of information for health workers is semi-organized, and there is no systematic information for patients;

6. no monitoring mechanisms exists;

7. There is a research capability leading to discovery of New Chemical Entities (NCEs).

8. China pharmaceutical industry is manufacturing type rather than R&D type. No patent protection for pharmaceuticals is one major reason for little R&D in industry.

The UK[5]

In UK, as in other western countries, the post war environment promoted the development of improved healthcare system, which encouraged an increase in the market for drug, allowing the pharmaceutical industry to emerge as one of the most successful and fast growing sectors, relatively free from competition.

The UK pharmaceutical industry of 350 manufacturers includes some of the world's largest multinational research based companies (generally known as the seven UK owned R&D companies); as well as middle sized and smaller specialist companies. Its gross output in 1989 was around **£6 billion**.

Britain's place as the world's third largest exporter of pharmaceuticals is reflected in the fact that in 1989, it exported **£2142 million**, 32% of the industry's gross output. Approximately 75% of UK pharmaceutical exports in 1989 went to the "rich" OECD countries with the US being the single largest customer. These highly competitive markets are also the principal sources of UK pharmaceutical purchases from abroad which amounted to £1062 million in 1989. The UK pharmaceutical industry's principal markets in 1989 are NHS 42% of gross output, exports 32%, household medicines 12% and other 14%. The net UK balance of trade generated by pharmaceutical in 1989 was **£955 million.**

The pharmaceutical industry invested more than £800 million in R&D in 1989. This sum amounts to more than 10% of all manufacturing industry's R&D expenditure in UK, representing 18% of total European expenditure on medicines research and 8% of the total world pharmaceutical R&D expenditure.

It is currently estimated that the cost of discovering a major innovative medicine has risen to £125 million and it takes between 10 and 12 years before a product reaches the market.

British pharmaceutical companies make 11 of the world's 50 best selling medicines in 1989.

According to the WHO assessment (1988), the availability of drugs is assured in most developed countries including the UK. At the manufacturers' prices, the UK market for

5 data in this section is from Britain 1991, and ABPI Pharm Facts and Figures 1990.

pharmaceuticals was 3,441 million pounds in 1989, equivalent to an average spend of 60 pounds per head. This represents about **0.7%** of GDP and 10% of national healthcare expenditure.

The quality control system and drug regulatory system function properly. The 1980s has been characterized by the strengthening of the drug regulatory agencies, the promotion of information for health care professionals and the public, and the development of post market surveillance. Recently there is a trend for governments of developed countries to squeeze pharmaceutical companies in attempt to reduce healthcare expenditure.

Summary on drug situation in China and UK

It is reported that the pharmaceutical prices in China are only 10% of that charged in the West. Although the drug consumption per capita in China is much lower than the world average, only 3.1 Pound in China comparing to 60 Pound in the UK in 1989; the ratio of domestic medicines sale to the GDP in China (**1.6%** in 1985) is higher than that in the UK (0.63% in 1985 and steadily rose to **0.7%** in 1989); and the percentage of domestic medicine sale against the national health care expenditure in China (around **60%** in 1985) is much higher than that in the UK and other developed countries (**10%** for the last thirty years). All these may reflect the high valuation given by the Chinese people to the medicines for providing good health.

China has a pharmaceutical trade volume of **$600 million** with surplus **$200 million** in 1985. Of the total export (in value), about 40% are bulk pharmaceuticals and 60% are from TCM herbal. In 1987, China exported **$400 million** or **¥1.5 billion** of pharmaceuticals (bulk pharmaceutical only) accounting for **10%** of the industry gross output (WM industry).

The UK pharmaceutical industry includes some of the world's largest multinational research intensive manufacturers. Its export value were **two billion pound** (or **$3.2 billion**, for exchange rate see Appendix 2.3) with trade surplus nearly **one billion pound** in 1989. The export valued **32%** of UK pharmaceutical industry gross output. UK continues to be the third largest exporter of pharmaceuticals in the world. The export capacity of the Chinese pharmaceutical industry (WM) is only about **12.5%** of the UK industry.

The UK ethical pharmaceutical industry has the three major features: their products are the result of extensive R&D, are patent protected and are available on prescription only. Britain is one of the top seven investors in pharmaceutical R&D in the world. In 1989, about eight hundred million pound were spent on R&D by UK pharmaceutical industry, which account for 18% of total pharmaceutical R&D spending in Europe and 8% in the world. UK has the most sophisticated drug distribution and legislation system[6].

On the other hand, there is a developing and expending pharmaceutical industry in China. It mainly operates in domestic market with 90% self satisfaction. Its products are not patent protected. It has a small R&D capacity and international marketing capacity (confined to bulk pharmaceutical intermediates and TCM raw material), and is not sophisticated in its distribution and legislation system.

3.2 Organization of Medicines Research in the Two Countries

In UK medicines research, there is a strengthening partnership which exists between the pharmaceutical industry, the academic sector and the National Health Services (NHS). Although, the division of S&T work among them may not be so clearly and accurately distinguished, it is generally known that academic institutes are mainly involved in basic research, NHS researchers mostly concentrate on clinical study, and the UK pharmaceutical industry is largely responsible for medicines innovations.

The Association of British Pharmaceutical Industry (ABPI) with 117 member companies includes not only companies with their headquarters in Britain, but also many others with parent concerns in the USA, Switzerland, Germany, France, Italy and elsewhere. All are part of the British research based industry, employing S&T staff in the UK, and also investing in production and domestic and foreign marketing activities. In all more than half the approximately £700 million UK pharmaceutical R&D expenditure in 1988 came from British owned majors (7 leading companies like Glaxo, ICI, etc.), and just under half from American, Swiss, and other sources (ABPI British Medicines Research, 1988).

Glaxo Group is the second large pharmaceutical company in the world. It has subsidiary companies in nearly 50 countries, employing about 30,000 people, of them 2,500 work

6 More detailed discussion on **drug regulation and legislation** is in Chapter 7 and Chapter 8.

in the R&D sector in UK (data from the Glaxo Information Division, 1989). Its organizational structure is shown in **Figure 3.1 & 3.2**. The R&D sector is one of the most important parts of the multinational company.

Research activities in China are mainly found in the following sectors:
1. institutes under the academies; 2. universities and colleges; 3. institutes under the ministries; 4. provincial and municipal research institutions; 5. defence.

As in the UK, there are three sectors involved in the pharmaceutical field in China- the industry, the national health system and the national S&T system. **(Figure 3.3-3.4)**

As far as R&D of pharmaceuticals is concerned, the following ministerial systems constitute the major "task force" in China:

1. Ministry of Public Health (MPH) system, with 50 pharmaceutical colleges or departments belonging to medical universities, 411 research institutes, 14 ministerial R&D labs, 7 national labs and total 4800 S&T staff. The specialized pharmaceutical institute in MPH is *Institute of Material Medical of Chinese Academy of Medical Sciences* with several hundreds of S&T staff.

2. State Commission of Family Planning (CFP) system, with 24 research institutes, two national labs and several hundreds of S&T staff.

3. State Pharmaceutical Administration of China (SPAC) system. SPAC is a government department at the ministerial level. It is in charge of the overall administration in pharmaceutical field, covering the production and distribution of pharmaceuticals. It also runs educational and R&D institutions with 57 research institutes, around two hundreds large factory based S&T units. There are 7,500 S&T staff in academic sector and 10,000 S&T staff in industrial sector.

4. State Administration of Traditional Chinese Medicines (SATCM) system (the system has just become independent from SPAC since 1988), with 60 research institutes and 16,314 S&T staff.

5. Chinese Academy of Sciences (Academia Sinica) system, the life sciences branch with 27 research institutes, 11 national labs, and 9,000 S&T staff; and the chemistry branch with 15 institutes and 8000 S&T staff. *The Shanghai Institute of Material Medical in Academia Sinica* with 400 S&T staff is the one of the best institutes in the field in China. It is also the only specialized pharmaceutical institute in Academia Sinica.

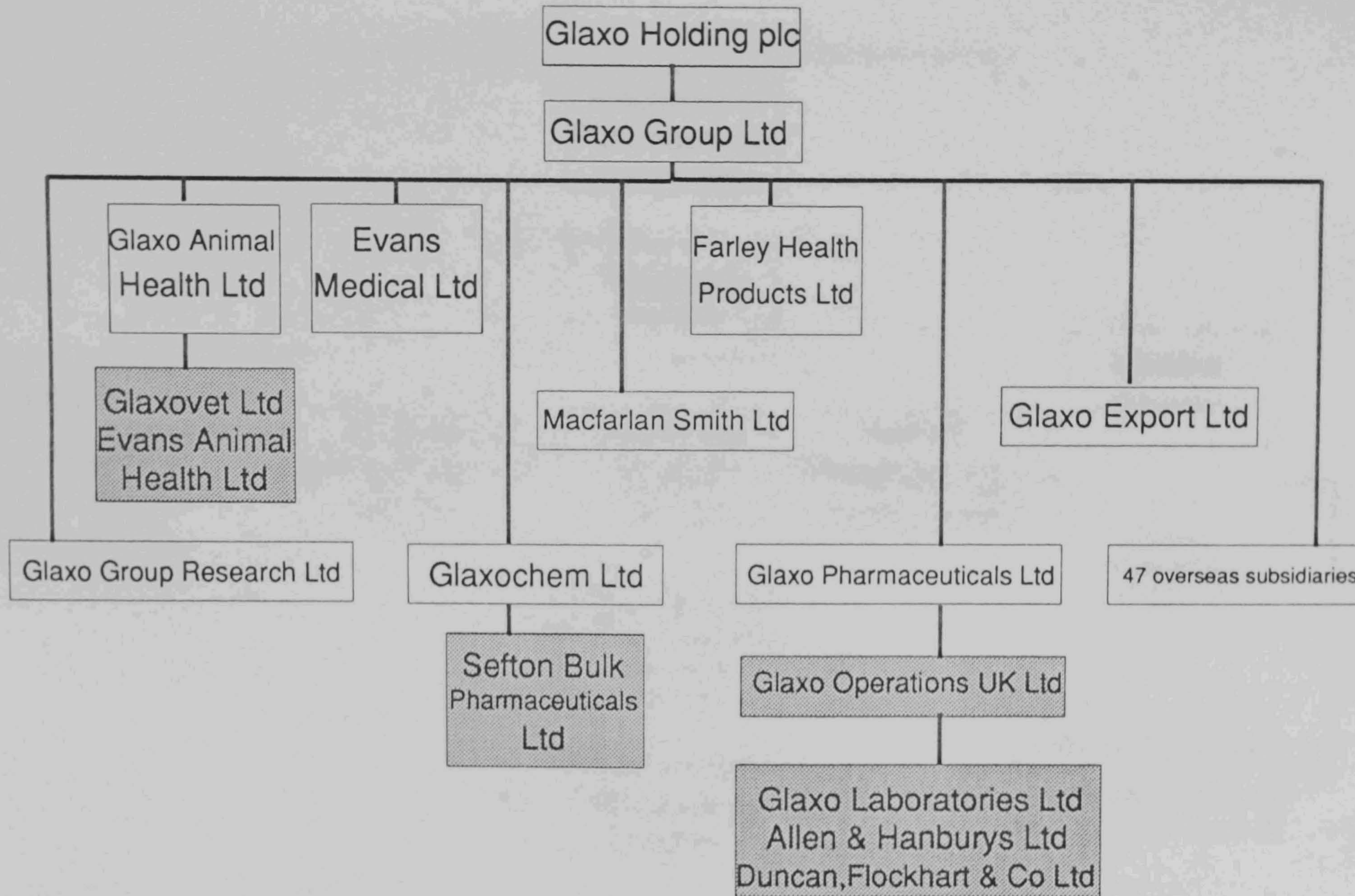

Fig. 3.1 Glaxo Group Organisation Chart

(source from Glaxo Booklet, 1985)

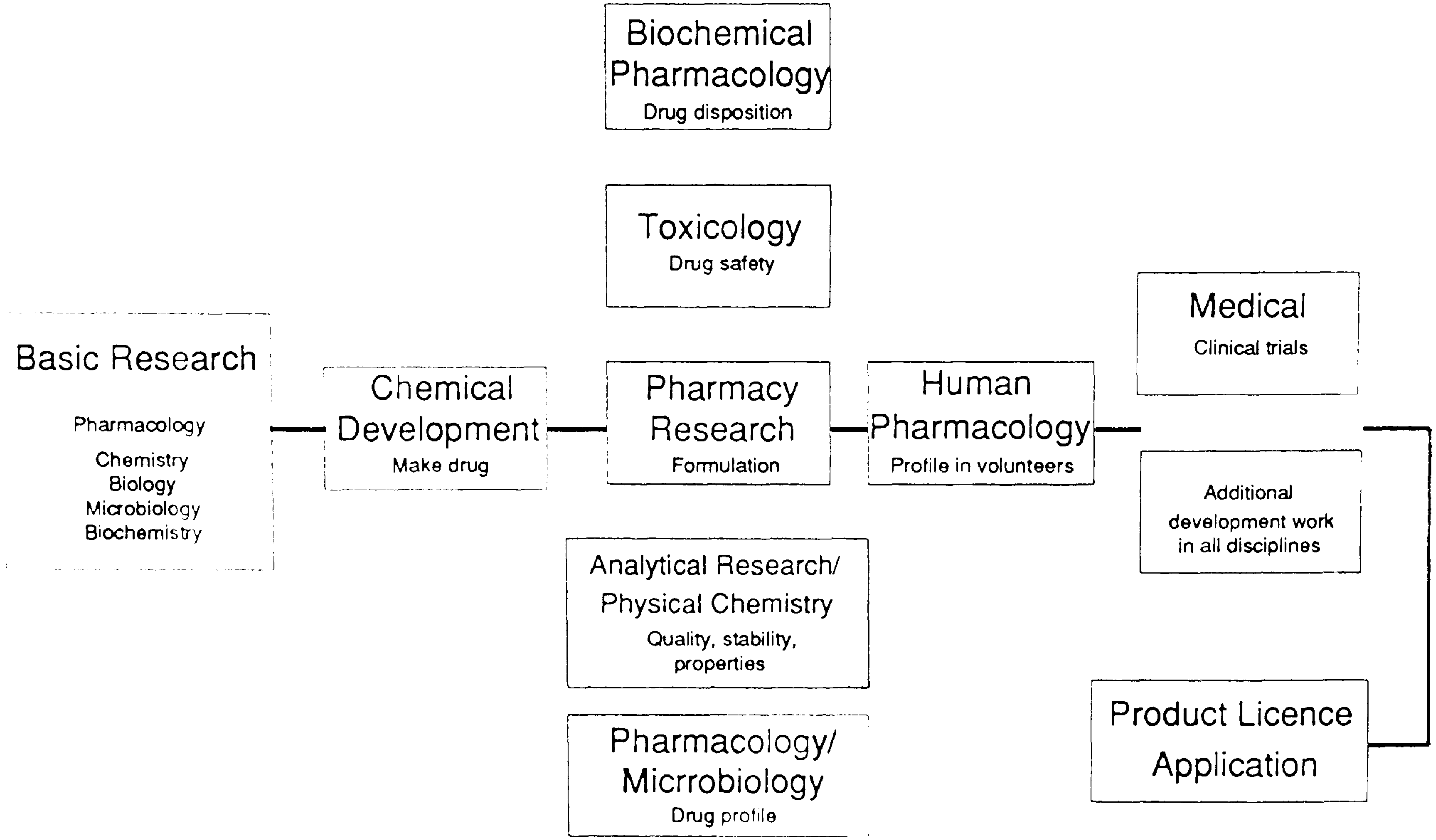

Fig 3.2 Glaxo's Teamwork in R & D
(source from Glaxo Booklet, 1985)

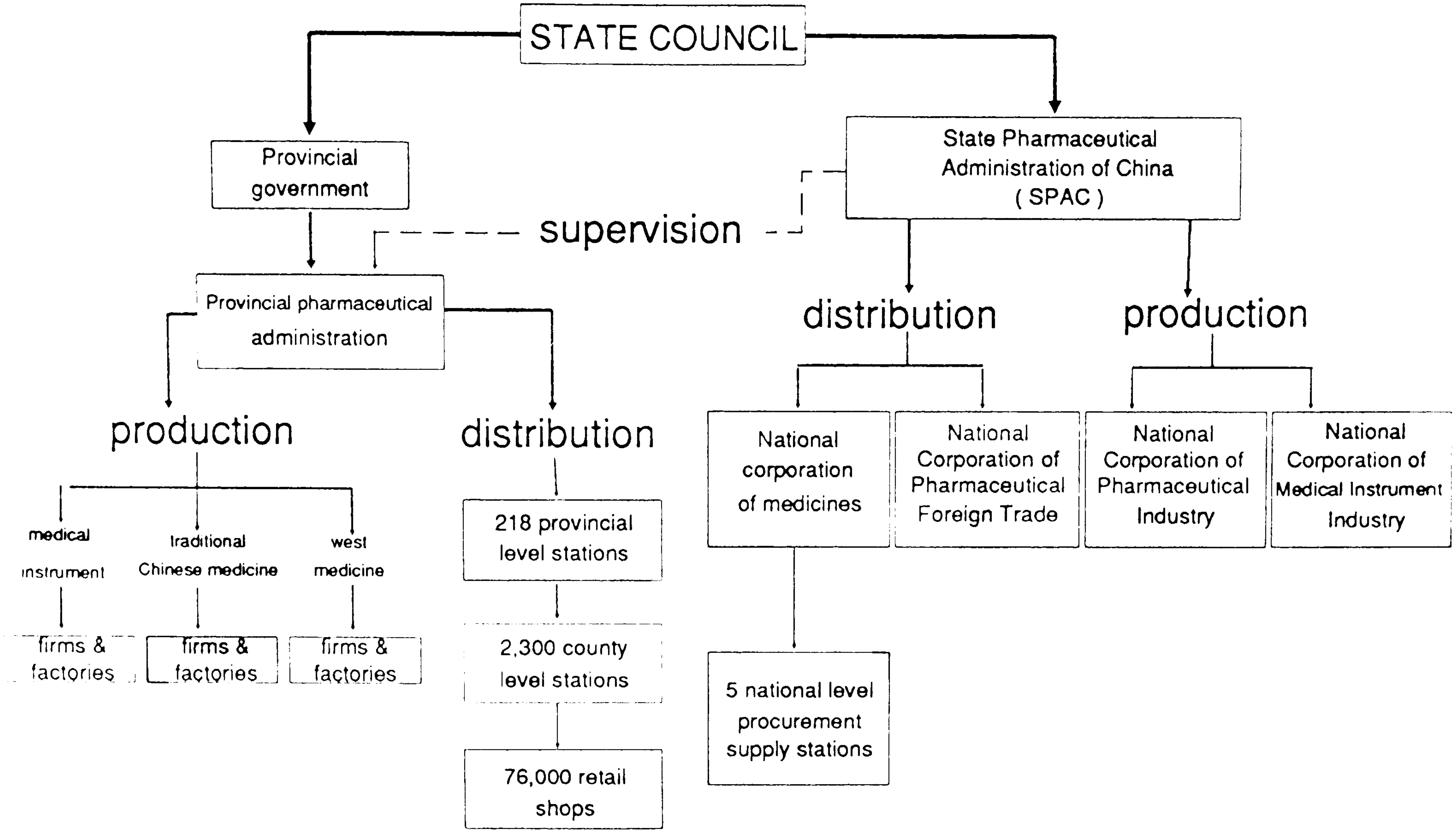

Fig 3.3 The Administrative Structure of Chinese Pharmaceutical Industry
(source from SPAC Booklet, 1989)

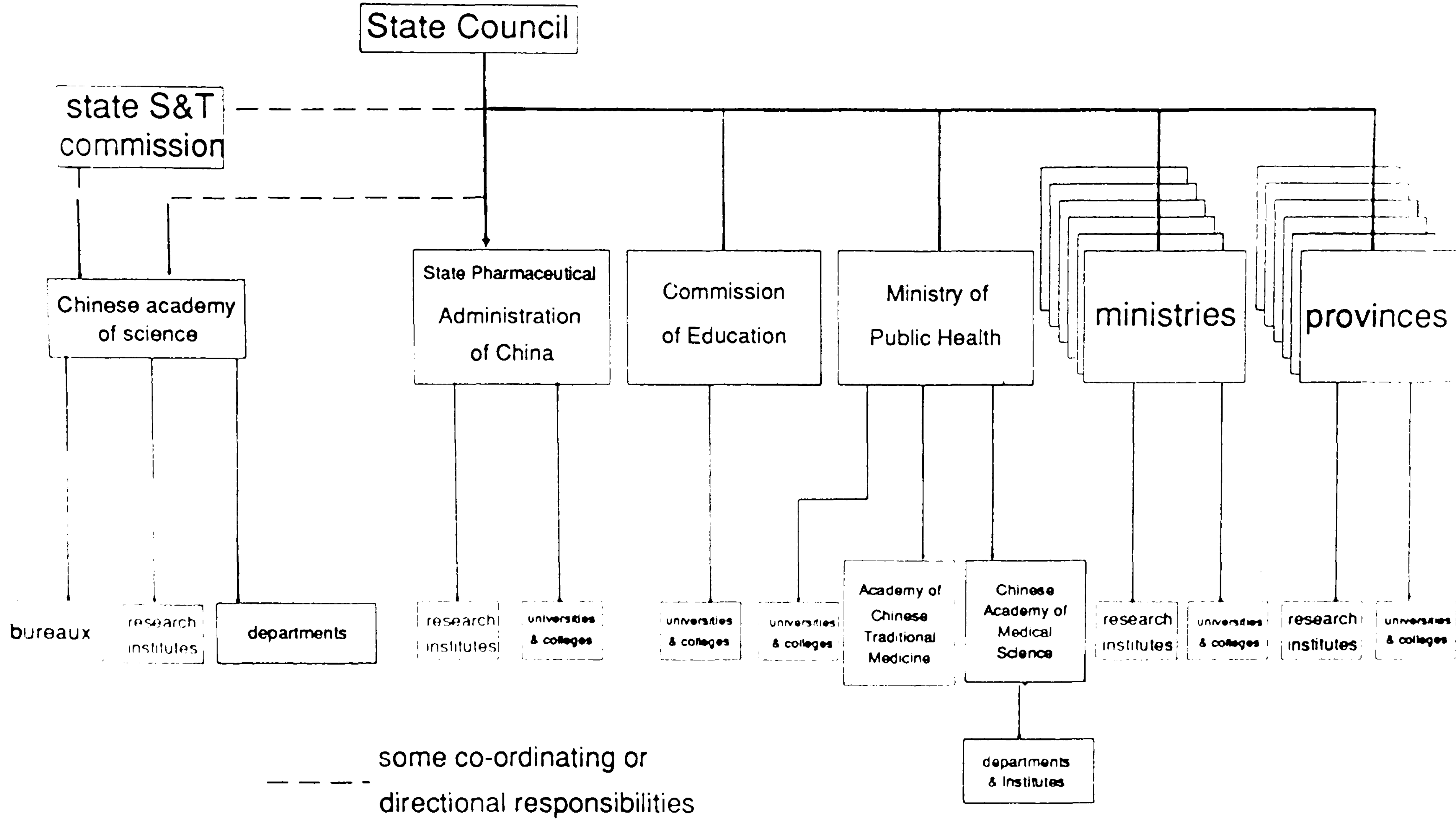

Fig 3.4 Chinese Scientific and Technical Organizations
(source from Infor. China, 1989)

6. People's Liberation Army system, with 23 medical research institutes, 41 middle class labs, and 12 national labs.

Above all, there are **120** academic research institutes in SPAC and SATCM, **236** industrial R&D units plus several dozen pharmaceutical related institutes scattering among MHP, Academia Sinica, CFP and military system. Those R&D institutions constitute the major force in medicines research in China. The total pharmaceutical R&D staff in China totalled **35,000** in 1988 (S&T staff in SPAC and SATCM only). (National Medicines Exhibition, 1990 July & White Paper, 1990).

In China more than 70% of R&D activities take place in academic institutions while less then 30% in industry based R&D units. According to the State Science and Technology Commission (SSTC), in 1986, 55% of national R&D expenditure were spent in government institutes, 15% in universities and 30% in industry. By comparison, most of the British national R&D expenditure is in industry (65% of total) while academic institutions get only a small fraction (35% of total) (White Paper, 1990).

Although the S&T reform starting in China in 1985 is aimed at the effective and quick S&T transfer from academic laboratory to industrial production, the divorce of research activities from industrial production is still serious and a radical change will take long time. The Chinese Government Awards for Innovations in medicines research (1959-1985) and The New Drugs Approved by the Chinese Authority (1986 - 1987) may in a sense reflect the status of collaboration between academic institutions and factories (**Table 3.1 and 3.2**).

Among the 100-200 pharmaceutical research institutes, and hundreds of medical colleges and big hospitals, only 14 institutions got 35 awards out of a total of 43 during the period of 1959 - 1985, accounting for 81% of the total awards (Green Book, 1988). These 14 institutions include : *Shanghai Institute of Pharmaceutical Industry* which got 9 awards (21% of total awards); seven institutes from *Chinese Academy of Medical Sciences* which got 13 awards (30% of total); six institutes from *Chinese Academy of Sciences* which got 13 awards (30% of total). All these 14 institutes are located in Shanghai and Beijing.

Among the two hundred pharmaceutical factories with R&D units, the top six have got 14 of the total 43 awards (1959 -1985). They are the North-East factory which got 3 awards, the Hebei factory (3 awards), the Tianjin factory (2 awards), the Beijing factory (2 awards), the Shanghai NO. 3 factory (2 awards) and the Shanghai XIYI factory (2 awards).

Table 3.1 The Chinese Government Awards to Medicines Research 1959-1985
(Green Book, 1988)

	Number of Awards	by institutes	by factories	by collaboration of factory and institution
Total	43	21	5	17
New Drugs	25	16	1	8
Technical Innovations	18	5	4	9

*The Chinese Government Awards for Innovations are issued annually to about 5% of total just finished projects in all S&T fields.

Table 3.2 New Drugs in China 1986-1987
(Chinese Pharmaceutical Affairs, Vol.2 No.1, 1988)

	Total number of new drugs	Number of new drugs made by institutes	Number of new drugs made by factories	Number of new drugs made by collaboration of both
Total of western medicine	21	7	8	6
Class 1	7	4	0	3
Class 2	0	0	0	0
Class 3-5	14	3	8	3
Total of TCM	9	1	4	4
Class 1	1	0	0	1
Class 2	2	1	0	1
Class 3-5	6	0	4	2

The figures mentioned above have shown a very clear distinction between leading institutions or factories and ordinary ones in S&T capacity. The most advanced pharmaceutical research mostly takes place at *the Institute of Material Medical in Chinese Academy of Medical Sciences in MPH,* Beijing.; *Shanghai Institute of Pharmaceutical Industry,* in SPAC; *Shanghai Institute of Material Medical; Beijing Institute of Microbiology; Shanghai Institute of Biochemistry* in *Chinese Academy of Sciences.*

Table 3.2 shows that of the seven first class western medicines, four were developed by academic institutes, the remainder three were from the collaboration of academic institutions and industrial R&D units. Among 14 Class III to Class V western medicines, however, 8 were from factory based R&D units, 3 from collaboration and only 3 from academic institutions.

All these indicate that in China, high standard medicines innovations usually take place in the academic sector rather than in industrial sector. Innovations on TCM show a similar pattern as well.

The distinction among areas of China in capacity of medicines research is just as significant as it is among institutions. The distribution of Government Awards of Medicines Research Innovations among areas is given in **Table 3.3**.

Table 3.3 Distribution of Government Awards for Medicines Research among Areas (Green Book, 1988)

Areas*	Rank	Number of Awards	percentage of total 43 awards
Shanghai	1	21	49
Beijing	2	17	40
Northeast	3	5	12
Guangdong	4	5	12
Sichuan	5	4	9
Wuhan	6	4	9
other** 7 provinces	7	13	30

* represented by institutions or factories

** including Tianjin City

Generally, medicines research is concentrated in Beijing., Shanghai, and Tianjin, with supplement by a handful of other big cities, most of them are the capital cities of the provinces concerned. Moreover, the biggest state owned pharmaceutical factories are also concentrated in the above ten to twenty big cities of China.

Among those cities, both Shanghai and Guangzhou (the capital of Guangdon province), have the longest history of marketing and producing Western Medicines dating back to the 1850s. In the last ten year economic reform, they have benefited more than other cities from foreign science and technology as well as foreign investment by taking advantage of their geographically coastal positions.

Summary on medicines research organization in China and UK

In UK pharmaceutical industry, half of total annual R&D expenditure is concentrated in the 7 largest British companies. The tendency of concentration in pharmaceutical research also happens in China where 14 of two hundred government institutes and 6 of two hundred industrial R&D divisions have contributed 80% of the highest standard research of the country.

In the UK, like other advanced countries in the world, the R&D of new drugs has mostly fallen into the pharmaceutical industry sector due to the high cost, high risk and high profit.

By comparison, in China the R&D of new drugs has been dominated by a dozen of biggest government institutions because of the concentration of S&T resources there.

3.3 Status of Medicines Research in the Two Countries

The thousand or so medicinal compounds in current use have been developed from a few score of prototypes of which only a small proportion were able to meet all clinical requirements without the need for further development. These prototypes consist of active principles extracted from plants, mammalian hormones; antibiotics from microorganisms; and an assortment of synthetic compounds whose therapeutic potential was mostly revealed by serendipity, a fortunate blend of chance and man's sagacity.

I. CHINA

It is well known that there are two systems of medicines research in China - Western Medicine (WM) and Traditional Chinese Medicine (TCM). The most distinguished characteristics of both medicines research and health care in China for the last 40 years has been the combination and integration of these two medicines systems.

Traditional Chinese Medicine, one of the world's oldest medical sciences, dates back to 1000 B.C.. It is a great treasure chest with a sophisticated theoretical basis and a wide therapeutic armamentarium, on a par with Western Medicine. It does not mean that difficulties in research do not exist, of course. In pharmacology, those Chinese medicines that are herbal in origin often suffer from the problem of standardization in ingredients: plants of the same species but growing at various localities differ in detailed compositions that may or may not affect therapeutic effectiveness.

The variety of TCM discovered is huge - more than five thousand different raw medicines or herbals have been identified in China. So far, only 800 of them have been chemically and biologically studied and classified. In the industrial sector, about 4000 types of TCM preparations or brand products of definite standard compositions have been produced for the last 40 years. All these TCMs constitute a solid research field to be explored (TCM 1949-1989).

To achieve the integration of Western Medicine and Traditional Chinese Medicine, it is necessary to apply western pharmacological knowledge to the TCM study.

So far, basic pharmacological study has been undertaken to 150 out of the total 5000 TCM herbals. Around 500 medicinal active agents have been isolated or extracted from TCM (TCM 1949- 1989).

In China now, **isolating bioactive substances** from TCM herbals or other natural sources and **molecular modification or synthesis** of bioactive agents chemically similar to known substances identified from TCM herbals are the most important ways of new drug development. Since 1949, 150 new drugs have been developed along these two lines, accounting for more than 50% of the total number of new drugs have ever been developed in China.

In the 1980s, several Chinese new drugs have attracted world-wide attention and won international awards. One of the outstanding achievement is the new and effective antimalarial drug *QINGHAOSU* (1987)with a chemical structure entirely different from those based on quinine. Qinghaosu is also the first few China new drugs which have been underdeveloped through a full R&D process meeting all WHO requirements for efficacy and safety tests (TCM 1949-1989).

The other important way to develop new drugs in China is molecular modification of existing western drugs for the enhancement of potency, the enlargement of the spectrum of activity, and the increase of the therapeutic ratio.

Above all, based on a rich resource of 5000 TCM herbals and several thousand years of experience in TCM practice, Chinese scientists in some 200 academic institutes and 200 industrial R&D units have been making great efforts to catch up with the advanced countries in new drug discovery and development for the last four decades.

In the 1950s, China concentrated its smaller S&T resource in R&D of antibiotics, sulphonamides, anti-infectives, antipyretics, vitamins and drugs for endemic diseases and tuberculosis. In the 1960s and 1970s, China started R&D on steroids, cancer drugs, contraceptives, and cardiovascular drugs. In the 1980s, medicines research in China have become more sophisticated and mature covering more research areas. *China Pharmaceutical Yearbook 1987* has reviewed the state of art on medicines research in China. By 1987, major progress have been made in the following areas:

1. TCM herbals identification and classification; revising and translating ancient TCM literature;

2. Investigation on geographical distribution of TCM herbal resource;

3. Theoretical study on TCM; applying and introducing western pharmacological science and technology to TCM study; western scientific style pharmacological and toxicologic test and clinical evaluation are given to many TCM herbals, empirical preparations and brand products;

4. Identification, isolation, synthesis and molecular modification of active substances from/in TCM herbals or preparations or brand products;

5. New dosage forms and drug delivery routes research;

6. Pharmacological study has been carried out in all major categories:

(1). medicines which may enhance or moderate the action of naturally occurring "neurotransmitters";

(2). medicines which enhance or moderate the action of hormones;

(3). medicines which modify the activity of enzymes;

(4). medicines which serve to enhance or moderate the activity of the immune system;

(5). medicines affecting cell growth and/or function;

(6). medicines which serve to destroy alien pathorgans;

7. basic theoretical research on Quantitative Structure Activity Relationship, pharmacological receptor hypothesis, etc.;

8. toxicology research;

9. great emphasis on biotechnology;

10. antibiotics research;

11. contraceptive research;

12. chemical pharmaceuticals - design and synthesis; new chemical entities in the following therapeutical areas: cardiovascular, cancer, contraceptive, infective, immune system etc.;

13. vaccines research;

14. pharmaceutical analysis process, modern techniques have been introduced to determine that pharmaceuticals conform to specified standards of identity, strength, quality and purity; they are: ultraviolet spectrophotometry, infra-red spectrophotometry, chromatography, polarography etc..

Finally it needs a few more words to describe the progress in *Clinical Pharmacology* in China. To strengthen its export capability in the world pharmaceutical market which is a new target brought in by the economic reform in the late 1970s, China has to introduce a full drug R&D process which could meet regulatory requirements for drug efficacy and safety in major countries. Those regulatory requirements, primarily related to human safety issues, has made toxicologic evaluation and clinical evaluation on a new drug a more time consuming and costly process. It is reported that *clinical pharmacology* become known as a science in the late 1960s and early 1970s in the world (Dukes, 1985).

Generally clinical pharmacology was built up in China some ten years later than in the world. Since 1978 when the first Chinese clinical pharmacology conference was held, clinical pharmacology has made great progress in China. In 1980, Clinical Pharmacology Research Institute was founded in Beijing Medical University which is the first institute in clinical pharmacology in China. Since then, several dozen of research institutes or departments in the field have been built up around the country. In 1983, MPH announced the first batch of 14 *national new drug clinical trial hospitals* which serve to carry out clinical evaluation on new drugs applying for product licence in China. In 1985, Chinese Journal of Clinical Pharmacology (CJCP) was first published by Clinical Pharmacology Research Institute, Beijing Medical University.

II. the UK

It is well known that British medicine innovations have been contributing to the health of people world-wide, and to the " great treasure chest " of human scientific knowledge. One example is that five of top 20 best selling medicines in 1987 and 11 of top 50 in 1989 in the world have been innovated by British scientists, and three of them occupied the top three places (ABPI Annual Report 1987-1988 & Britain 1991).

Since the beginning of the Pharmacological Revolution in Europe in the 1930s, substantial progress has been made in many areas - such as the control of bacterial infection and high blood pressure, the new treatments for mental illness, bronchial asthma and peptic ulcer disease. The ABPI report *"British Medicines Research 1988"* has summarised 28 therapeutic groups of new drug approaches currently being investigated by British researchers.

The opportunities open for pharmaceutical researchers in advanced countries like the UK have in the last decade or so been greatly enhanced. Relevant technical advances include the increased range of scientific equipment available for conducting analytical and other measurements, and for observing clinically disease processes in patients; the increased sophistication of animal models vital for developing new ways to treat human complaints; the emergence of molecular biology based techniques as powerful new research tools; and the progressively expanding role of computer based molecular modelling in pharmaceutical innovation. Britain has been leading in the development of molecular graphics, which contribute to the rational design of new drugs through a computer aided technique for analysing the structures of complicated organic molecules on a visual display unit.

The advanced process of drug discovery today involves a melding of many disciplines and interests. Up to 50 major disciplines are required to handle the range of programs normally found in a major multinational research based pharmaceutical company.

Although there may be the difference in S&T organization among companies, the R&D procedures for new drugs are similar among all major research based companies. Modern scientific teamwork, project management and effective communication in this procedure has been described in detail by Brown (1985).

Step 1. Project definition

The proposal by a scientific or marketing team to embark on the search for a new drug for a major human disease requires each discipline represented in the project to collect and evaluate the extant data/information/ knowledge. Sources must include proprietary stores, published literature and patents. In addition, it is not just the initial retrospective search but an ongoing commitment that must be made.

Step 2. Discovery

In many R&D projects, assignments in the early stage frequently rest with chemists and biologists. Activities centre around the collection of compounds and their biological testing by a defined protocol. The chemist frequently uses a variety of sources for the test compounds - synthesis, collection from sample/catalogue stores, microbial broths, plant extracts and molecular modification of known drugs. In recent times, rational drug design has received more attention. This may stem from hypothesis regarding the pharmaceutical or enzymatic nature of the disease process - frequently involving an agonist or antagonist for a known enzyme and its substrate. Molecular modelling, using three dimensional models has proven stimulating to medicinal chemists.

Whatever the source of the compound, the major goal in this phase is to discover a novel structure with interesting biological effect as measured in enzyme inhibition, perfused organ, or whole animal model.

Large volumes of new data are generated by each of the disciplines involved. It is practical to limit the number of substances that pass this first *"Screen"* to 1-2% that is 100 to 200 out of 10,000 testing compounds. It is not just the chemical synthesized but ancillary data that must be collected, evaluated, and recorded. Spectral data are extremely valuable and form the first recorded indication of a given chemical structure. This becomes very valuable in patent application or infringement prosecution. For laboratory records, data and record management protocols need to be followed. These are usually derived by the proprietary information scientists. Proprietary reports generated by team scientists must be collected, indexed, and stored for later use.

As the proprietary data is generated and evaluated in the search for a new drug, the published literature and patents must be combed routinely by information scientists. Bioassay procedures, new reports of biological activity, and especially quickly published foreign patents are reviewed to keep track of competitive activity in the chemical structure or bioassay areas of interest. Known toxicity for closely related chemical structures is collected and disseminated to the team members.

Success in this phase is the finding of one or more structural types that possess interesting biological activity and offer a chance for novelty (patent protection), and represent a class of chemicals not usually perceived as toxic. After patents are granted, there is a peak of scientific publication on medicines research.

So far, the discovery normally takes 3-20 years.

Step 3. Lead development

In this phase, one or more structural types that possess "interesting" biological activity needs to be exploited further. Efficacy and safety are dominant , but chemical novelty is very important for patent protection. Systematic structural variation is applied by the medicinal chemists to determine the chemical attributes that have influence on the specific biological activity of interest.

On the biological side, it is important to have a whole animal model for pharmacological study. Biologists provide sufficiently quantifiable data for regression analyses to determine what quantitative structure activity relationships exist.

It is usually during this phase that a sound basis for patent application is found.

So far, the lead development (i.e. pre-clinical safety) normally takes 2-4 years.

Step 4. Drug development

From the last stage a prime candidate is selected for development as a product. Development chemists prepare bulk chemicals for safety studies, pharmaceutical dosage forms, and ultimately for clinical studies. Pharmacists initiate studies to determine the salt/derivative form, dosage form preparations, and stability studies. Safety assessment units start studies in the appropriate species to fill out "the Application for Clinical Trial Certificate" (ACTC in UK, or "Investigational New Drug Application" (IND) in US).

In preparation for the filling out the ACTC, all major disciplines must search the proprietary literature with the help of information scientists to locate any reports of toxicity for the candidate or its close relatives.

Clinical studies

At this stage, pharmaceutical companies initiate planning for the clinical phases. Investigators must be contacted and contracts drawn for the required studies. Claims targets must be defined vs. patient populations to be studied. Case reports need to be carefully designed and filed.

During the drug development phase, the original chemical and biological team is now extending patent coverage, seeking second generation of candidates and preparing manuscripts for publication (when management feels the patent application are on a firm footing).

Information scientists responsible for proprietary information must collect, index, store and retrieve all documents associated with the development. This usually means a new file is started when the drug candidate is selected.

Application for Product Licence

After the clinical studies, compilation of the "Application for Product Licence" in UK (or "New Drug Application" (NDA) in US) is the major undertaking, resulting in the creation of hundred volumes of information. The final application is frequently delivered in a truck.

So far, the clinical safety and efficacy normally takes 3-7 years.

Step 5. Market launch

From this stage, the dominant in information work is shifted from S&T information to business information, drug information, statutory information etc.

Step 6. Post market surveillance

Despite substantial clinical investigation of a new medicine before registration, unpredictable and rare adverse drug reactions (ADR) may still occur in the post-marketing phase. At the present time, the only practicable alternatives are large post-marketing surveillance studies, or voluntary reporting. In the UK, this is achieved through the "yellow card" reporting system operated by the Committee on Safety of Medicines (CSM). The scheme is based on spontaneous reporting by doctors of suspected ADRs.

After launching a new drug, a pharmaceutical company is responsible for any inquiries about its product and for monitoring adverse drug reactions (ADR).

Summary on medicines research status in China and UK

In western advanced countries, such as the UK, progress in comprehending the basic nature of disease and the mechanisms involved in the healthy functioning of the body is currently taking place faster than ever before. Along with that, since the 1930s there has been a remarkable revolution in drug discovery that has led to the development of carefully designed chemical substances.

Chinese medicines research has long been walking on the two legs - Traditional Chinese Medicine and western medicine. Taking the advantage of several thousand year experience in using TCM and of several thousand kinds of raw TCM herbals, Chinese researchers could heavily rely on natural sources for drug development. On the other hand, applying western science and technology to the development of both TCM and western medicines; and molecular modification of known Chinese and western drugs have long been the major target of Chinese pharmaceutical R&D. By the end of the 1980s, China has had a more sophisticated and mature pharmaceutical science and significant progress has been made in many subject areas even including the most advanced fields such as *Rational Drug Design, Molecular Biology and Molecular Modeling*.

However, in the world-wide competition in pharmaceutical innovation and in innovative pharmaceutical market, China is still being left behind by the developed countries including UK. This issue will be discussed in more detail in the next section §3.4 ***size of medicines research in the two countries.***

3.4 Size of Medicines Research in the Two Countries

There are many ways to define the size of medicines research. Unfortunately, most of them are harder to quantify than the following four methods- measuring the number of scientists in existence, the amount of money expended on research, the amount of new drugs, and the amount of literature published.

I. Scientific Manpower

As described above, the UK pharmaceutical industry is mainly responsible for the medicines research in Britain, the measurement of S&T manpower in this study will focus on the industrial sector. On the other hand, the measurement of China's S&T manpower in pharmaceutical field is to be focused on government research institutes and industrial R&D units, neglecting the relatively small research force in universities.

The UK pharmaceutical industry has a R&D manpower of sixteen thousand (ABPI British Medicines Research, 1988). The Chinese pharmaceutical industry has a S&T manpower of 33,800 (Data from SPAC and SATCM statistics, 1989).

Table 3.4 and 3.5 give the figure of S&T manpower in the UK pharmaceutical research and in the Chinese pharmaceutical research. The total number of S&T staff employed by the UK pharmaceutical industry is only 42% of the Chinese counterpart. However, the proportion of S&T staff to total employees in the UK pharmaceutical industry is as high as 23% which is 6 times the Chinese figure (3.4%). This is a typical example of the devastating shortage of S&T manpower in China. For instance, there were **724,238** senior doctors in China comparing to **51,300** whole time equivalent medical and dental staff in hospital and community service and **58,700** medical, dental and optical staff employed under the auspices of family practitioner committees in the UK (Shao, 1988). Despite the number of Chinese doctors is **seven times** the number of British doctors, the proportion of pharmacists and doctors to the population in China is much less than that in the UK and other developed countries (**Table 3.6**).

To measure Britain and China S&T manpower at different work categories and at different levels has proved to be very difficult, because of the different situations in medicines research and different organization systems in the two countries.

Since the mid 1960s there has been a tendency in the USA and to a loser extent in the UK to regard a Ph.D degree as the qualification of a practitioner of research (Meadows, 1974). But the situation in China is quite different, because the major R&D force in China has long been the S&T staff with first degree.

China started post-graduate education much later (in 1977) than its modern inception of science and technology (in 1910s). At present, of China's S&T manpower higher degrees holders compose too small proportion to be considered an substantial research force. The proportion of doctoral degree holders in total S&T manpower is 0.26%, the proportion of master degree holders is 3.18%. However the proportion of first degree

Table 3.4 The Employment and S&T Manpower in British Pharmaceutical Industry*
(ABPI facts' 1986 and *1990)*

Year	1970	1975	1980	1981	1982	1983	1984	1985	1989
Total Employees (in thousands)	71.0	76.0	74.0	81.1	81.0	80.9	81.4	82.5	71.0
R&D (in thousands)	7.0	10.0	12.0	13.0	13.0	14.0	14.1	14.2	16.0
R&D in Total (%)	9.9	13.2	16.2	16.0	16.0	17.3	17.3	17.2	23.0

*All figures include part-time staff

Table 3.5 The Employment and S&T Manpower in Chinese Pharmaceutical Industry*
(Green Book, 1988)

Total Employees (in Thousands)	1000
S&T (in Thousands)	33.8
S&T in Total (%)	3.4

* All figures include WM and TCM S&T staff.

Table 3.6 Proportion of Qualified Doctors and Pharmacists to the National Population-comparison among selected countries (Han, 1988)

Country	Year	Doctors per 1,000 residents	Pharmacists per 1,000 residents
Japan	1980	1.34	0.99
U. S. A.	1975	1.68	0.68
U. K.	1977	1.52	0.68
W. Germany	1975	2.04	0.48
China	1986	0.75	0.05

holders is **46%** of total S&T manpower in China which is much higher than the figure of **33%** (degree holders to the total S&T manpower) in the UK (White Paper, 1990 & Annual Review of Government Founded R&D 1990).

R&D employment in UK pharmaceutical industry was composed of administrative, clerical staff (29%); technical support staff (33%) and research scientists and engineers (38%) in 1981 (ABPI, 1985).

If we assume the above ratio (38%) is unchanged, we can estimate there are now **six thousand** R&D personnel and ten thousand supporting staff in the UK pharmaceutical industry.

In the short history of modern S&T in China, there are the following "**four generations**" of intellectuals (**Table 3.7**).

Table 3.7 Four Generation of Chinese University Graduates

generation	graduation year	number of graduates (million)	percentage (%)	ages in 1990
1st	1911-1949	0.22	5	65-80
2nd	1950-1965	1.5	36	50-65
3rd	1966-1979	0.96	23	35-50
4th	1980-1985	1.5	36	30-35
Total		4.18	100	

The *first generation* (1911-1949) of graduates was studying in colleges or universities before liberation in 1949. Most of them have already retired from work, with only a few still remaining in university teaching posts. The *second generation* (1950-1965) are those who were educated before the *Cultural Revolution*. Their studies and initial phase of their research careers were mostly influenced by the Russian Mode, followed by ten years of unemployment in R&D field during the *Cultural Revolution*. When in the early 1980s their scientific work was restored, they found themselves facing a huge challenge and influence from the western science and technology. Nevertheless, the *second generation* is playing the most important role in today's R&D in China, owning to their long experience and high reputation in the S&T field. The *third generation* (1966-1979) is probably the most controversial group of the four in the Chinese S&T

and higher education history. Because of the higher education guide-lines during *Cultural Revolution* aimed at training factory workers, peasants and soldiers into *revolutionary experts*, the quality of the *third generation* is questionable. It has been officially estimated in 1986 that only 25% of the college graduates during the period of 1966-1979 were really qualified graduates (White Paper, 1987). In 1978 China restored its national higher education system which includes various courses ranging from *two year Diploma* to *Post graduate course for Master and Doctoral degree*. The graduates since 1980 are labelled the *fourth generation*. Unlike their parents (the *second generation*), from the beginning of their higher education the *fourth generation* has been studying and working in an information environment with enormous western influence.

After the 1960s and 1970s Cultural Revolution, there has been a serious shortage of professionals in many fields, especially in the S&T sector. To meet the great demand for qualified S&T staff, China needs to strengthen its high education system. For the last ten years, most of Chinese higher degrees graduates have been assigned to lecturing posts in universities or colleges. A relatively small proportion of them went directly to R&D posts in academic or industrial sectors.

According to a survey of 294 Master degree holders graduated from 1981 to 1987 in pharmaceutical sciences in China (China Pharmaceutical Yearbook, 1987), 63.3% of them have been engaged in university teaching; 20.4% of them were employed by research institutes, 11.9% of them have undertaken further education for doctor degree, 4.4% have been employed by industrial enterprises, hospitals or other organizations. That is less than **40%** of higher degrees holders are engaged in R&D work.

By comparison, relatively bigger proportion of UK higher degrees holders in pharmaceutical sciences has gone into R&D sector, according to the First Destination Survey by the Department of Education of the UK in 1989. Approximately, of the higher degree graduates, **86%** in Pharmacology, **58%** in Biology and **71%** in Chemistry started working in R&D sector. Generally speaking the quality of research staff in UK is higher than in China.

Up to now, whether one has a first degree or a higher degree is not a criteria for the grades of research scientists in China. In stead, the *hierarchy of job titles* in the Chinese R&D system divides all S&T staff into four classes or levels, according to both research experience and professional skill. The *hierarchy* is described as follow:

Grade 4 - research assistant, accounting for 30% (40% of total research scientists),
Grade 3 - junior research fellow, accounting for 30% (40% of total),
Grade 2 - research fellow,
Grade 1 - senior research fellow (the first and second classes accounting for 10% -20% of total).[7]

In practice, the top two classes (Grade I and Grade II) of S&T staff are mainly involved in research and literature produce; while the lower classes of staff (Grade III and Grade IV) act mainly as supporting workers. In this sense, the ratio of R&D personnel to supporting personnel is **1 to 4**.

To measure S&T manpower at different levels or categories of work enable us to estimate the number of potential scientific authors and readers.

Generally speaking, it is research scientists who constitute both the potential author group and the reader group. According to the above estimates (1/3 of UK pharmaceutical S&T staff and 1/5 of Chinese pharmaceutical S&T staff are regarded as research scientists), there are about **six thousand** and **seven thousand** potential pharmaceutical authors and readers respectively in the UK and China.

II. Expenditure on R&D of medicines

Over the past 50 years, innovative research within the UK pharmaceutical industry has been among the most consistently successful of all UK industries with six of the top 15 products in the world originated by the UK companies (Lumley, 1989).This success has been largely dependent on investment in research and development. A survey of pharmaceutical companies in the UK has shown that total research and development expenditure increased by 103% from £331.5 million in 1982 to £672 million in 1987, with an estimated expenditure of £748.8 million in 1988 and an average yearly change of 15%. Even after correcting for inflation, the increase from 1982 to 1987 is considerable at 61.7%. Capital expenditure made a significant contribution to this increase, rising from 14% of total expenditure in 1982 to 24% in 1988. The seven UK owned companies alone accounted for more than half of total pharmaceutical R&D expenditure in 1987 (Lumley, 1989). The figure quoted above indicate the magnitude of the research investment in the pharmaceutical industry. It is now estimated that it costs on average

7 the proportion of different classes vary among research institutes (White Paper, 1987, 1990).

about £125 million to develop one successful new medicine (ABPI Pharm Facts 1990). The British pharmaceutical industry expenditure on R&D as a proportion of gross output (13.4% in 1985) is much higher than the average figure of the whole UK industry (at 1%) (Baker, 1989). **Table 3.8** is given to show the growth of R&D expenditure since 1970.

There are no statistics about the expenditure on medicines R&D in China. What we have got is the official statistics on national S&T expenditure (**in government institutes only**) classified into different ministries or provinces (China Economy Statistics Yearbook 1988). **Table 3.9** gives the figure of national S&T expenditure which includes the State Council controlled research and the provincial or municipal controlled research. Among the State Council controlled research groups, we choose the following five concerned with medicines R&D: 1. research under the administration of the Ministry of Public Health (MPH); 2. research under the Commission of Family Planning (CFP); 3. research under the State Pharmaceutical Administration of China (SPAC); 4. research under the State Administration of Traditional Chinese Medicines (SATCM); 5. research under the Chinese Academy of Sciences (Academia Sinica). These five groups either entirely or partly involved in medicines research are higher level institutions in China where R&D expenditure per person is much higher than the average national ratio and provincial ratio (Table 3.9).

The provincial or municipal controlled R&D expenditure is divided among those lower level or small scale institutions. The R&D expenditure per person in provincial research is ¥8,232 which is lower than the average national ratio ¥10,403 (Table 3.9). Here it should be pointed out again that R&D expenditure figures in Table 3.9 only reflect the situation in academic sector in China.

It must be noted that the expenditure of the above five State Council controlled groups is not totally allocated to medicines research; and there is a proportion of the provincial research expenditure spending in medicines research. It is too difficult to get any figure on total R&D expenditure on medicines in China or any figure on average R&D expenditure for each new drug in China.

Table 3.8 R&D Expenditure in British Pharmaceutical Industry

(ABPI facts' 1986 and *1990)*

Year	R&D (£ million)	R&D in Gross Output (%)	R&D* per person (£)
1970	30	5.7	4,286
1975	79	7.5	7,900
1980	251	10.3	20,917
1981	296	11.2	22,769
1982	360	11.8	22,692
1983	431	13.2	30,786
1984	483	13.2	34,255
1985	540	13.4	38,028
1986	612	13.8	
1987	668	13.3	
1988	743	13.0	
1989	871	13.8	55,438

*not corrected for inflation

Table 3.9 R&D Expenditure in China in 1987

(China Economic Statistics Year Book 1988)

	S&T staff	Number of institutions	R&D expenditure (million ¥)*	R&D expenditure per person (¥)
National	1,042,675	5,568	10,847	10,403
MPH	20,233	36	255	12,582
CFP	218	1	1.8	8,349
SPAC	2,368	5	39	16,584
SATCM	3,145	8	48	15,179
Academia Sinica	66,855	123	886	13,255
provincial	454,504	4,490	3,742	8,232

* The exchange rate in 1986 is £1 = ¥5.51

We try to calculate a rough figure by multiplying total S&T staff number in medicines field by national average R&D expenditure per person in the field:

10,403 (¥)	×	23,800	=	247,591,400(¥)
average national R&D expenditure per person in 1987		total R&D staff in medicines research in academic sector in 1987		total R&D expenditure in medicines research in 1987

Therefore, it is estimated in 1987 total R&D expenditure on medicines research in academic sector in China was ¥247.6 million (RMB). This figure does not include R&D in pharmaceutical industry, because there is no official data on industrial R&D expenditure available. However, we could roughly estimate the pharmaceutical industry R&D expenditure according to the share of R&D expenditure among government institutes (55% of total), universities (15% of total) and industry (30% of total) in 1988 (White Paper, 1990). Therefore the Chinese pharmaceutical industry R&D expenditure in 1987 is estimated as ¥135 million. In the whole, the annual pharmaceutical R&D expenditure is estimated as ¥382.6 million in 1987 in China.

The proportion of Chinese R&D expenditure to its pharmaceutical industry gross output in 1987 is estimated as 1.5% - 2.0%, given China's pharmaceutical industry gross output in 1987 was ¥21 billion (China Medicines Economic News, No. 39, 1 Oct. 1989 & China Pharmaceutical Yearbook 1987). So the UK pharmaceutical industry's ratio of R&D expenditure to its gross output (13.4% in 1985 and 14% in 1989) is about 7 times the China's ratio.

In 1987, the exchange rate was £1 = ¥6.97 (Appendix 2.3). Therefore the Chinese Pharmaceutical R&D expenditure in 1987 was about £55 million and annual R&D expenditure per person was between the low level of £1,515 (in CFP) and the high level of £3,010 (in SPAC). If we compared the whole expenditure (£55 million) and expenditure per person (£1,500-3,000) with the UK counterparts (£800 million in total and £54,000 per R&D staff in 1989 see Table 3.8), the UK figures are more than ten times the Chinese ones.

If we compare the average R&D cost of each NCE in the two countries, the difference is even more surprising. In the UK in the 1989 the average cost of one successful NCE was about **£125 million** (ABPI Pharm. Facts and Figures, 1990). In China, there were 60 pharmaceutical R&D projects with total fund of ¥3 million in 1988 (White Paper, 1990). If we assume that these 60 project are associated with **one** new drug, then the cost of a new drug was about **£500,000** (for exchange rate see Appendix 2.3). The R&D expenditure for each NCE in UK is over **200 times** the Chinese figure.

In fact, it is not so valid to compare the two countries' R&D expenditure in absolute terms of money, because there are two different economy systems in the two countries.

The price system in China is very low comparing to those in UK, USA and other western countries, only very small amount of R&D expenditure are located on S&T manpower. Additionally in the domestic market, S&T hardware and software are also comparatively quite cheap.

For example, the average annual wage in 1989 of a full time UK pharmaceutical industry employee was £14,452 (ABPI Pharm. Fact 1990), accounting for just under **30%** of average annual R&D expenditure per staff in pharmaceutical industry (£54,438 in 1989, see Table 3.8). By comparison, the average annual earning in 1990 of Chinese employee was ¥2100 (Peoples' Daily, March 27, 1991) which accounts for **17%** of average annual S&T expenditure per person (¥12,870 in 1990) in China (White Paper, 1990).

Another example is the low price for domestic books and periodicals. In China, in 1990 the regular price for a S&T book was about ¥13 (or £1.3 under the official exchange rate in 1990) and for a S&T journal the average annual subscribing fee was ¥16.5 in 1990 (or £1.65 under the exchange rate in 1990) (Tao, 1991).

By comparison, in 1986 the UK average academic book price was £14 and the USA book price was £20; the UK average scientific journal price was £60 and the USA figure was £108 (Fletcher, 1987).

If we divide the average wage by the average book/journal price, we have the following results:

(1) a Chinese employee's annual wage can buy 161 Chinese S&T books or subscribe 127 Chinese S&T journals;

(2) a British (pharmaceutical industry) employee's annual wage can buy 723 British or American academic books or subscribe 134 British or American academic journals.

It is also said that the price of domestic made S&T equipment is also very low in a sense that ¥1 of spending on equipment in China market is equal to £1 of spending on equipment in the UK market (Ma, 1990).

Having said all that, one must also notice the obvious financial constraint in China R&D sector.

China has to rely on the import of high technology equipment and S&T documentation expensively from the western countries. This part of expenditure accounts for the largest part of S&T expenditure in China.

In 1987, the Shanghai Institute of Pharmaceutical Industry, one of the largest institution in the field in China, spent about ¥200,000 on information acquisition. By dividing the annual documentation expenditure by its 1,000 S&T staff, the average annual documentation expenditure was ¥200 or just under £30 per staff (according to the Shanghai Institute of Pharmaceutical Industry statistics in 1989).

According to ICI Pharmaceutical Division, in 1985 its journal subscriptions was 38% of the **library materials budget**, others include online/SDI 26%, monograph 29%, BLDSC loan 3% and patent 4%. Over recent years it has subscribed average 1,400 serial titles. Given that ICI mainly purchase British and American journals and the average UK journal price was £60 per year (US price is higher than that), then one could roughly estimate that ICI spent £84,000 on journals or £221,000 on information (including 26% in SDI/online) each year.

According to ABPI Fact 1986, 17% of employees in UK pharmaceutical industry are in R&D sector. Since there are 4000 employees in ICI pharmaceutical division (Jackson, 1987), it is estimated that there are some 680 R&D staff in ICI pharmaceutical division. By dividing ICI annual information expenditure of £221,000 by 680 R&D staff, annual information expenditure was £325 per staff, which is almost ten times the Chinese figure.

Because China has to rely greatly on importing documentation from the Western countries, the existing R&D budget is far too limited. The Shanghai Institute of Pharmaceutical Industry only subscribes some 600 foreign journals each year, whereas ICI pharmaceutical division subscribes about 1,400 titles of current journals.

III. New Drugs

In the West, industrial researchers usually adopt "new chemical entity " (NCE) as the quantitative measure of pharmaceutical innovation. A new chemical entity is defined as " a new chemical or biological compound, not previously tested in man for therapeutic purposes, excluding new salts and esters unless they confer some major therapeutic advantage" (Walker, 1988).

Data on the number of NCEs do not give any indication of the quality or relevance of the pharmaceutical R&D. The FDA in USA and Barral in France have developed a classification on the 508 NCEs marketed in the world during the period of 1975-1984. It reported that 35 NCEs (6.9% of total) are in the group A *"new structure; therapeutic improvement;"*, 115 NCEs (22.6%) in the group B *"well known structure; therapeutic* improvement;", 75 NCEs (14.8%) in the group C *"new structure, no therapeutic improvement;"* and 283 NCEs in the group D *"well known structure; no therapeutic improvement"* (WHO, 1988).

Throughout the 1960s and 1970s, and in the early 1980s, only five countries in the world have dominated the world pharmaceutical industry in terms of NCEs and of R&D expenditure - they are the UK, France, West Germany, Switzerland and the USA. Since the early 1980s, Japan has become one of the leading countries in the world pharmaceutical industry (WHO, 1988).

The number of NCEs investigated by the UK owned research based companies was 319 from 1964 to 1985. There was an increase in the number of NCEs investigated each year in man - doubling from an average of **12** per year (1964-1980) to over **20** per year (1981-1985) (Walker, 1988).

From 1969 to 1989, the annual number of NCEs launched by UK pharmaceutical companies has fluctuated between 12 and 28. The annual number of UK companies involved in NCE launching has fluctuated between 12 and 24 (ABPI Pharm. Fact 1990).

From 1980 to 1989, European pharmaceutical companies were responsible for originating 42% of the NCEs reaching one of the 20 key countries' market (16 European countries and USA, Canada, Japan, or Australia), while US accounting for 27% and Japan for 31%. UK holds **14%** of NCEs introduced onto the 20 countries' market and **27.6%** of the top 50 products marketed world-wide with respect to the patent holders (CMR news, Vol 8 No. 4, 1990).

China has a definition and classification system of new drugs which is different from the NCEs system applied in other countries, in the sense that the Chinese new drugs include - western medicines (WM) and traditional Chinese medicines (TCM). TCM new drugs are not comparable with the NCEs defined above.

The Medicine Act introduced into China in 1985 defines and classifies a **new drug** as:

Class I. TCM

1. man made substitute for a TCM herbal or
2. newly found TCM herbal or
3. new medicinal part of a known TCM herbal

WM

1. a new chemical or biological compound and its preparation or formulation which has not been tested in man in the world or
2. a new chemical or biological compound and its preparation or formulation which has not been granted product licence in any foreign country

Class II. TCM

1. new preparation or formulation which change traditional delivery routes or
2. isolated substances (not a single compound) and associated preparation or formulation

WM

1. new compound and associated preparation or formulation which has been granted product licence in foreign country but not been indexed in pharmacopoeia in any foreign country or

Class III. TCM

1. new preparation or formulation of traditional Chinese medicine (ancient formulation, empirical formulation, etc..)

WM

1. new combine WM formulation or preparation; or TCM formulation or preparation

Class IV. TCM

1. new dosage form of TCM which does not change traditional delivery route

WM

1. synthesis of known compound existing in natural sources
2. new compound which has been granted product licence and indexed in

pharmacopoeia in foreign countries

3. new dosage form

4. new formulation which changes previous delivery routes

Class V. TCM

1. existing drug which has a new therapeutical function

WM

1. existing drug which has a new therapeutical function

Generally, the Chinese new drugs in the western medicine group are the equivalent of NCEs defined elsewhere in the world.

There are no official statistics on the number of new drugs developed by Chinese Scientists before 1985. One estimated number is three hundred or so during the period of 1949 - 1988 (TCM 1949-1989), an average of 8 new drugs per year.

There have been 25 medicines being given the Government Innovation Award from 1959 to 1985. These awards reflect the highest standard R&D achievements in drug discovery and development in China for the period. **Table 3.10** is the distribution of the awards over the years (Green Book, 1988).

Table 3.10 The Government Awards for Innovations in Medicine Research (Green Book, 1988)

Year	1960	1965	1979	1980	1981	1982	1983	1984	1985	total
Number	1	1	1	2	3	4	6	4	3	25

After 35 years of disperse administration on pharmaceuticals, the first Medicine Act was introduced into China in 1985.

Since then the new drug approval process in China has been under the full control of the Chinese central government and has been continuously improved to become compatible with the new drug approval process in the major countries in the world.

In 1987, 32 WMs and 11 TCMs developed by Chinese researchers have been approved for industrial production and marketing and granted *Product Licence*. Among the 43 new drugs, there were **32** NCEs (Chinese Pharmaceutical Affairs, Vol. 2 No. 2, 1988

& China Pharmaceutical Yearbook 1987). Comparing with average 20 NCEs being launched by UK companies each year, China is not out of line with UK in terms of NCEs launched per year.

However, these Chinese NCEs are not generally recognized by the world pharmaceutical industry, neither in the form of patent nor in the sale volume at the world market.

IV. S&T literature productivity

When talking about literature productivity in a specific field, a more acceptable measure is to count entries in the most comprehensive bibliographies or abstracting journals in that field. **Table 3.11 and 3.12** show the results of several countries' contribution towards the world literature by measuring their entries in Chemical Abstracts (CA). Both in general and in pharmaceutical field, China accounts for very small fraction of the world literature. In pharmacology, toxicology, pharmaceuticals and pharmaceutical analysis, China accounts for 1.4%, 0.8%, 1.8% and 0.4% of world literature in the field respectively while correspondingly UK is 7.1%, 6.1%, 5.5% and 2.4% in these fields. In these areas in 1988, China produced total 517 papers (as indexed in CA) while UK produced 3377 papers (in CA). China's productivity is only 1/6 of the UK.

Though CA is much more comprehensive in covering S&T literature not in English and literature by smaller scientific nations than other international abstracting services (Boxenbaum, 1981), the above counts of Chinese papers appearing in CA can only reflect a small fraction of and the best part of total Chinese S&T literature in the fields. **Table 3.13** compares the entries in CA and in "China Pharmaceutical Abstracts (CPA)" which is the most comprehensive Chinese abstracting journal in the field. The results show that total entries in pharmacology, toxicology, pharmaceuticals and pharmaceutical analysis in CA is equal to 15% of entries in CPA in the same fields. So in a catch all measure, China produces about 3,000 papers per year in pharmacology, toxicology, pharmaceuticals and pharmaceutical analysis; which is similar to the UK annual literature production.

Having said all that, we have to emphasise that almost all papers abstracted in CPA are written in Chinese and about **98%** of the Chinese papers in CA are in Chinese (Jhaveri, 1989). In world-wide scientific communication, these non-English papers have only little impact.

Table 3.11 National Productivity of S&T Literature
Under the Measure of CA Entries in 1988 (Jhevari,1989)

	journal papers in CA	% of journal paper in CA	patents in CA	% of patents in CA
World	389,685	100	80,795	100
USA	106,774	27.4	5,575	6.9
USSR	50,659	13.0	5,332	6.6
Japan	44,814	11.5	43,468	53.8
UK	21,822	5.6	-	-
W. & E. Germany	29,226	7.5	-	-
India	12,080	1.3	-	-
China	13,639	3.5	1293	1.6

Table 3.12 Pharmaceutical Literature Entries in CA in 1988
- comparison between UK and China*

	Pharmacology (SC1)	Toxicology (SC4)	Pharmaceuticals (SC63)	Pharmaceutical Analysis (SC64)
world	20445 (100%)	12353 (100%)	7165 (100%)	1371 (100%)
UK	1446 (7.1%)	752 (6.1%)	394 (5.5%)	33 (2.4%)
China	287 (1.4%)	99 (0.8%)	126 (1.8%)	5 (0.4%)

* the results are from the online searching counducted by information officer in the City University Library in Oct. 1990 through STN CAFILE

Table 3.13 Chinese Pharmaceutical Literature Productivity
- entries in Chemical Abstracts (1988) and in China Pharmaceutical Abstracts (1989)

	CA section	No. entries in CA	CPA section	No. entries in CPA
pharmacology & toxicology	SC1 & SC4	386	06 & 07	1479
pharmaceutcals	SC63	126	03 & 04 &05	1258
pharmaceutical analysis	SC64	5	08	745
total		517		3482

Summary and discussion on the size of medicines research in China and UK

Both China and the UK has a large number of S&T staff in medicines research - about 33,800 in China (including those working in WM and TCM), and 16,000 in the UK pharmaceutical industry. The estimated pharmaceutical R&D staff numbers are six thousand in the UK and seven thousand in China.

It is not valid to compare R&D expenditure in UK and China in the absolute terms of money, because of the different price systems in the two countries. In the West, the R&D cost of a new drug has reached £125 million in 1989. However, in China in 1988 the R&D budget for a new drug was estimated at the level of £500,000. The British pharmaceutical industry R&D expenditure has amounted to £800 million in 1989, accounting for 14% of the gross output of the industry. By comparison, it is estimated that in 1987 China has spent about ¥382 million (or £55 million) in pharmaceutical R&D accounting for only 2% of the industrial gross output.

However, as far as the import of high-technology and S&T documentation is concerned, the situation in China is very serious due to the shortage of hard currency. The annual information expenditure in ICI pharmaceutical division is about £300 per R&D staff, while the money spent on per Chinese S&T staff in pharmaceutical field is only £30 - a difference of ten times.

Although China has a R&D manpower in pharmaceutical industry as large as the UK, in terms of pharmaceutical R&D money input, it is obviously left behind by the UK. Lack of funds has had serious impacts on the output of pharmaceutical R&D in China.

The annual productivity of literature in pharmaceutical sciences (pharmacology, toxicology, pharmaceuticals and pharmaceutical analysis) is between two to three thousand in the UK (CA, 1988). The productivity in the same subject areas by China is between three and four thousands per year (CPA, 1989). However only 15% of Chinese papers are abstracted in CA. So China has a scientific productivity similar to UK in pharmaceutical literature. But in terms of literature disseminated into the world (i.e. the amount of papers being indexed in CA), China' capacity is only 1/6 of the UK. Furthermore only 4% or so Chinese S&T literature is published outside China and in English (see Chapter 6). That means only very small proportion of Chinese literature are accessible to foreign scientists without a language barrier.

By now, although the annual number of NCEs launched by China is not out of the line comparing with UK; in the world-wide competition in pharmaceutical innovation and in innovative pharmaceutical market, China is still being left behind by the developed countries including UK.

Firstly, the Chinese new drugs both TCM and WM are not world-wide recognized. China has no international market share of ethical pharmaceuticals.

Secondly, China's pharmaceutical export are almost confined to TCM raw materials and WM bulk chemicals.

On the other hand, UK is one of the seven "superpowers" in the world pharmaceutical industry. In terms of R&D expenditure - UK accounts for 8% of the world pharmaceutical expenditure in 1989; in terms of productivity of NCEs - UK accounts for 14% of world NCEs launched to 20 key countries during 1980-1989; and in terms of sales volume in world market - UK accounts for 31% of world prescription sale of £95 billion in 1989. The UK industry has its products that are results of extensive R&D, are patent protected, are available on prescription only and have a significant share of the world market.

The main reasons for the above differences include:

1. NCEs developed in China do not usually have patent protection both at home and abroad (see Chapter 8), therefore Chinese NCEs are less competitive in the home market and the world market.

2. The Chinese new drug registry system was just established in 1985 and not compatible with those sophisticated systems in the developed countries (see Chapter 8). So far, few Chinese NCEs could meet those complex regulatory requirements in the major counties in the world.

3. Chinese pharmaceutical industry mainly is the manufacturing type of industry rather than the R&D type of industry. Most of pharmaceutical innovations are taken place in government research institutes rather than inside the industry. The divorce of R&D activities from industrial manufacture has resulted in the following problems:

> (1) Because there is no direct link between the pharmaceutical innovation and the profit of the pharmaceutical industry, the R&D investment from the industry has been prevented[8].

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8 Other factors preventing the Chinese pharmaceutical industry from large R&D investment include the general low price for pharmaceuticals in the domestic market and no patent protection in China.

(2) The low R&D investment has resulted in that most of Chinese new drugs could not meet the regulatory requirements of foreign countries without undertaking **a full R&D procedure** as that being implemented in the West. This procedure is a very expensive one which takes 3-20 years for discovery, 2-4 years for lead development, 3-7 years for development and costs £125 million for a new drug to reach the market.

(3) Failing to meet international standards, most of Chinese new drugs are not able to be launched in the world market. This further weakens the foreign currency income of the Chinese pharmaceutical industry, while the hard currency is greatly needed for purchasing high technology and documentation from the West.

3.5 Concluding Notes

The drug situation and the pharmaceutical industry are significantly different in China and the UK.

China is a developing country with an essential drug policy. Although the drug consumption per capita is very small (£3.1 in China comparing to £60 in UK in 1989), the average pharmaceutical price in China is only 10% of that charged in the West. Furthermore, the Chinese society has given medicines higher value in terms of domestic drug sales vs. GDP (1.6% in China comparing to 0.7% in the UK) and of domestic drug sales vs. national health expenditure (60% in China vs. 10% in the UK and other developed countries). China, a country with 1/5 of world population, has reached the stage of 90% self sufficient in drug supply.

As a developing country China still faces problems in the legislation and quality assurance systems, drug information supply for professional and the public, ADR monitoring, and patent protection.

For the past 12 years the Chinese pharmaceutical industry has grown at a rate of over 10% per year. However, the role of the Chinese pharmaceutical industry is not so significant in terms of world pharmaceutical trading. Its bulk pharmaceutical export in 1987 accounts for **10%** of the Chinese pharmaceutical industry gross output (Western medicine industry only); comparing to the UK figure of **32%** in 1989. Its world trade volume ($400 million in 1987) is only **12.5%** of the UK figure ($3.2 billion in 1989).

Furthermore, China's pharmaceutical export are almost confined to TCM raw materials and WM bulk chemicals. Its new drugs are not generally recognized by the world. Its international marketing capacity of ethical drugs is very small.

The fundamental difference between the Chinese pharmaceutical industry and the UK pharmaceutical industry are in the pharmaceutical R&D, in patent protection and international market share. To narrow the distance between China and the West in the world-wide competition for pharmaceutical market, and to increase the national capacity of pharmaceutical innovation to serve the Chinese people, the following goals for development and transition have been set up by the Chinese government recently (China S&T Daily, July 18 1990):

1. From simply *molecular modification of existing drugs* to *discovery of new drugs,* that is to implement **a full drug R&D procedure** which will meet all regulatory requirements of the Chinese government in the first place, and meet all requirements in some major countries (markets) in the future.

2. From exporting *intermediary chemicals (bulk pharmaceuticals)* to exporting *ethical products.*

3. Fully introducing into Chinese pharmaceutical industry the **Good Manufacturing Practice and other international standards to improve product quality and** to promote the international marketing capacity of the Chinese pharmaceutical industry.

Above all, there is a long way for the Chinese pharmaceutical industry to transfer into a R&D industry. Such a development is bound to happen in the modernization process of the country. Such a development or transition will inevitably have impacts on the pharmaceutical information flow in China.

The most recent trend in the Chinese pharmaceutical industry is that early in 1992, the Chinese government agreed to introduce patent protection for pharmaceuticals in China. The implications include:

1. Chinese pharmaceutical manufacturers and foreign manufacturers have their ethical products protected by Chinese law;

2. Encouragement on pharmaceutical industry R&D and discouragement on copying

drug products "me too" drugs in China;

3. Market competition among Chinese and foreign companies in the Chinese market.

Since the Chinese pharmaceutical industry is moving towards modernization, an R&D based and ethical pharmaceutical industry is bound to emerge in China. In the mean time, other sectors of Chinese pharmaceutical activity- quality control, legislation, distribution, ADR monitoring and information provision- are also experiencing modernization. This means that studying the advanced UK pharmaceutical information flow model is very necessary for the future information flow system in China.

Chapter 4 The Growth of Science

To measure the performance of S&T information flow is difficult. Since the 1960s, there have been some studies that try to measure the worldwide scientific growth in manpower, expenditure and literature.

In this chapter, the growth of science in the world, the UK and China in the current century will be studied; the impact of the growth on Chinese scientific communication will be discussed.

Perhaps no one but Derek J. De S. Price has won such a high reputation in the field of measuring the growth in science. In the early 1960s, he stated:

"All of these [empirical statistical evidences] shows with impressive consistency and regularity that if any sufficiently large segment of science is measured in any reasonable way, the normal mode of growth of science is exponential.

"One of the important features of the growth of science is that it is surprisingly rapid however it is measured.

"Now, depending on what one measures and how, the crude size of science in manpower or in publications tends to double within a period of 10 to 15 years.

"The 10-year period emerges from those catch-all measures that do not distinguish low-grade work from high but adopt a basic, minimal definition of science; the 15-year period results when one is more selective, counting only some more stringent definition of published scientific work and those who produce it. If this stringency is increased so that only scientific work of very high quality is counted, then the doubling period is drawn out so that it approaches about 20 years". (Price, 1963)

However, in the real world things do not grow and grow until they reach infinity. According to Price, the growth of scientific manpower and publications follows a "normal" logistic growth curve (**Figure 4.1**). This is characterized by early exponential growth followed by a decline in growth toward a ceiling beyond which it cannot grow in its accustomed fashion.

In 1961, Price estimated that science in the USA was approximately entering the mid-region near the inflection. He predicted " 30 to 45 years will elapse before the exact midpoint between floor and ceiling is reached. An equal period thereafter, the curve will effectively have reached its limit". (Price, 1963)

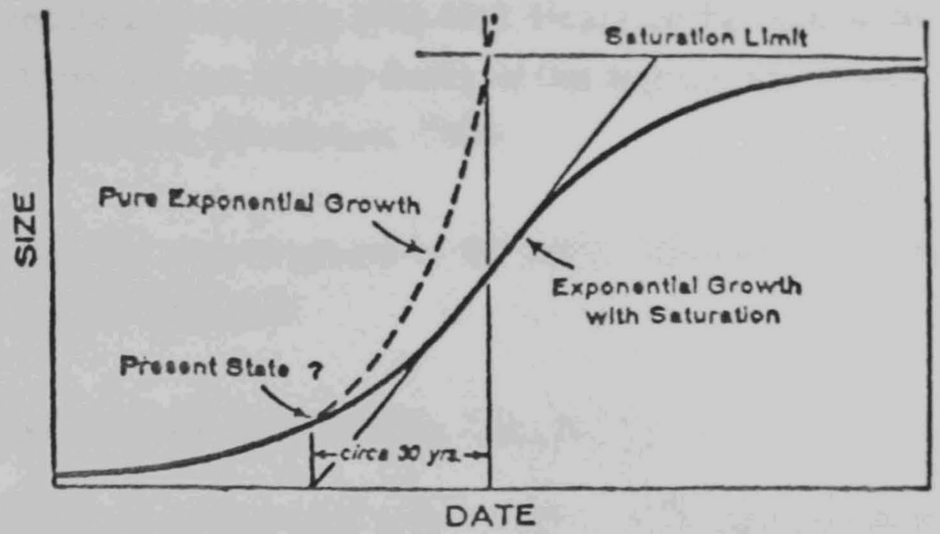


Fig 4.1 General form of the logistic curve
(after D. J. S. Price, 1961)

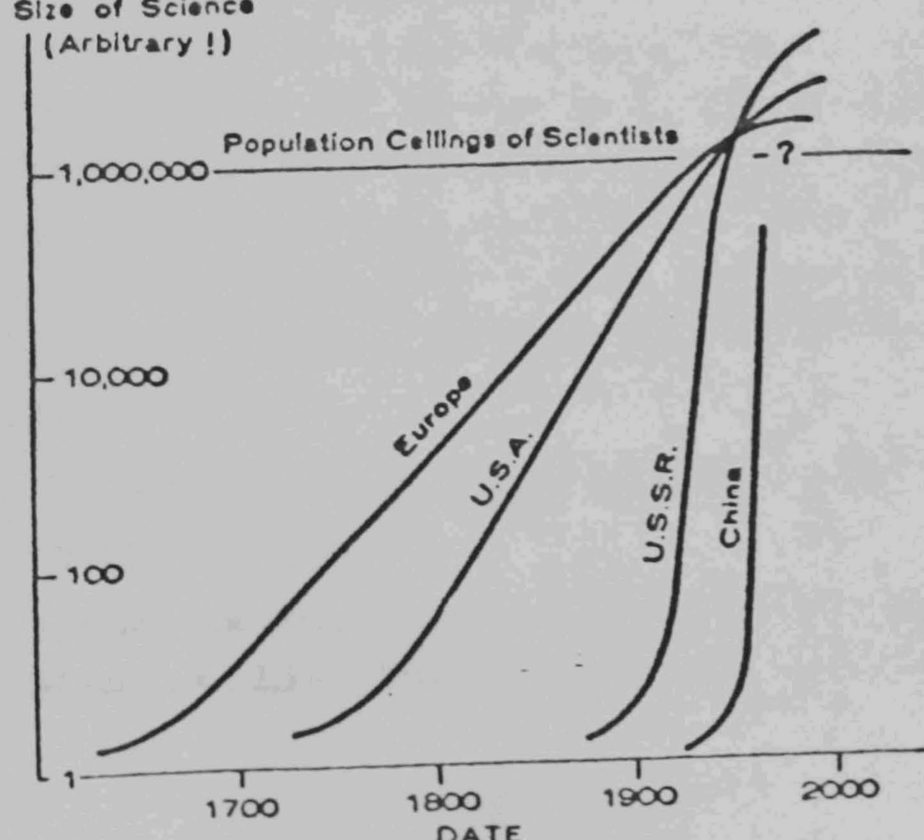


Fig 4.2 Schematic graph of the size of science in various world regions.
(after D. J. S. Price, 1961)

No matter whether Price's prediction is right or not, the world has seen that the growth of science has been slowed down during last 20 years. Along Price's line, A. G. Henderson has monitored the growth during 1900-1988. He argued that most of the developed countries like USA, Japan, UK are already facing or fast approaching stagnation in science under present circumstances. (Henderson, 1988)

Compared with the growth pattern in the world and in the UK, what is China's pattern during the last four decades?

4.1 The Growth in Scientific Manpower

The patterns of evolution of science vary significantly among continents as well as nations. As Price estimated, the USA has undergone the exponential expansion in science at a considerably higher rate than Europe. Later came the economic and scientific rise of the USSR and China with even higher expanding rate - the scientific manpower doubling period in the USSR is seven years while in China it is three to five years. **(Figure 4.2)**

Of many indicators Price has used to demonstrate the USA scientific manpower growth, the number of entries in the biographical directory "American Men of Science" (AMS) (1st. Edition of 1906 -- 10th edition of 1960) is one of the more accessible. A. G. Henderson studied the latest 6 editions (11th of 1967 -- 16th of 1986) which has changed its name to "American Men and Women of Science" (AMWS) ever since. **Figure 4.3** shows that the US scientific manpower reached the peak in the late 1960s and started to decline afterwards. For the period of 1900-1960, USA S&T manpower doubled every 12.5 years (Price, 1963).

For an exponential growth, the average annual growth rate (R) and the doubling time (T) are calculated as follows:

Given Y_0 is the value of the initial year, Y_t is the value of the year which is t years after the initial year, t = 1,2,3,4...; Then the relationship of Y_t and Y_0 is:

$$Y_t = Y_0(1 + R)^t$$

Here R represents the average annual growth rate.

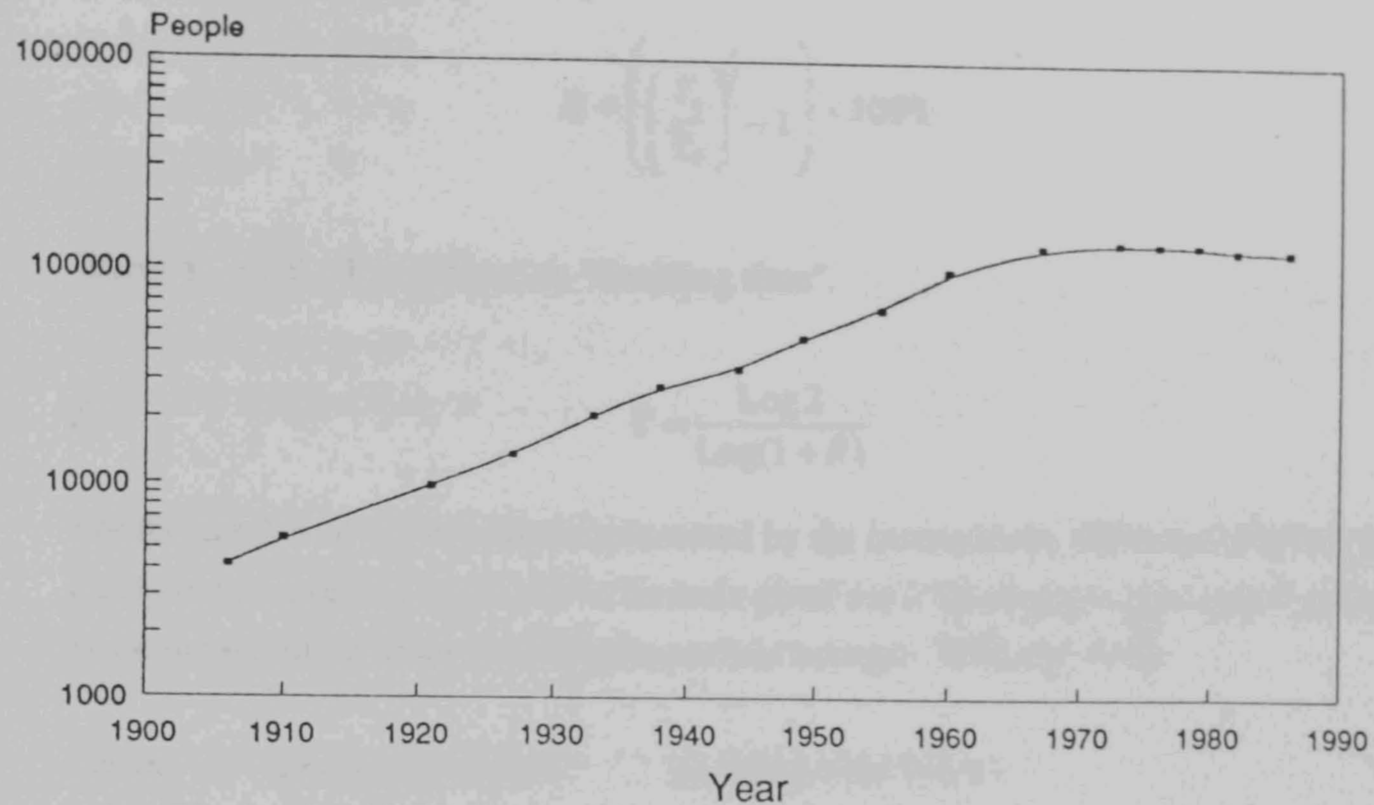


Fig. 4.3 Semilog Plot of Entries in AMS
(Henderson, 1988)

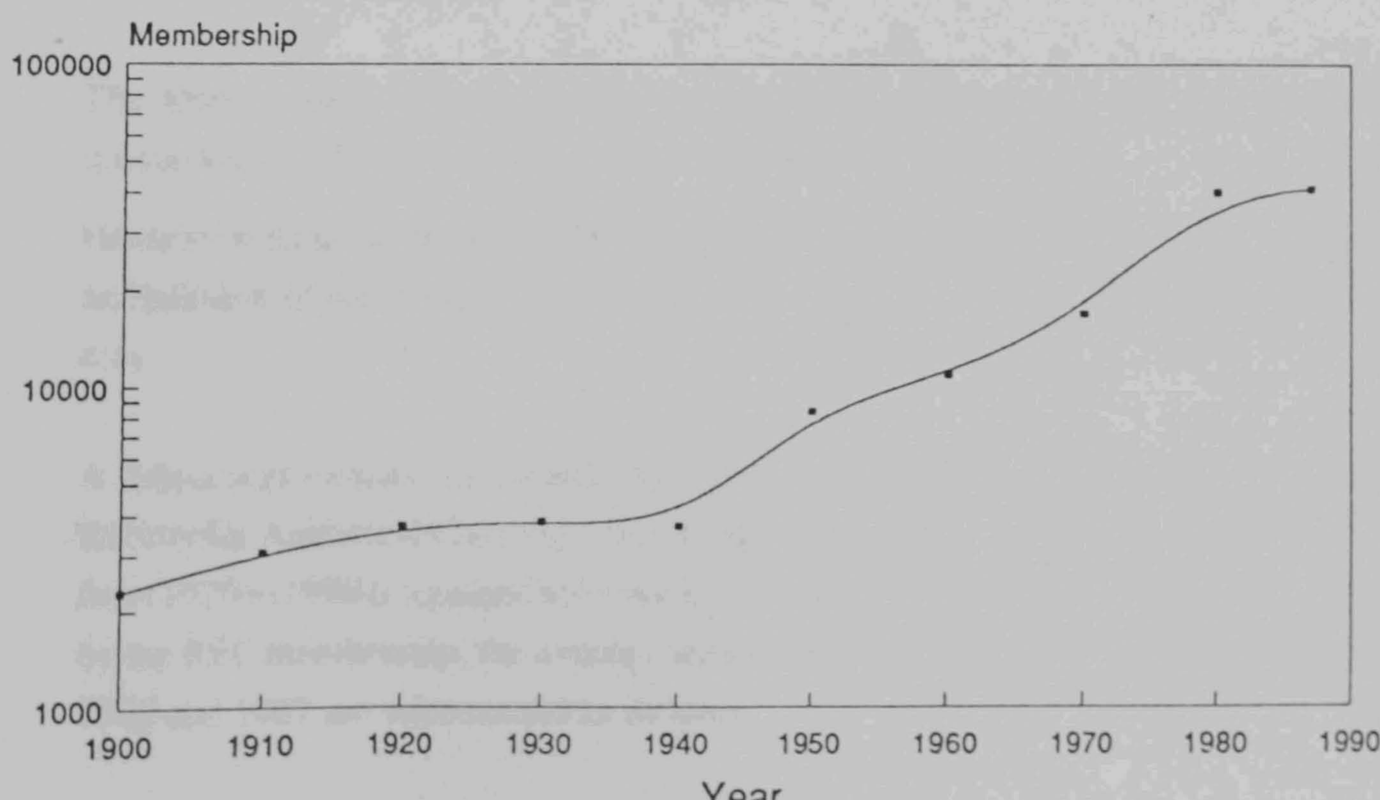


Fig. 4.4 Semilog Plot of RSC Membership
(Henderson, 1988)

Therefore

$$R = \left(\left(\frac{Y_t}{Y_0} \right)^{\frac{1}{t}} - 1 \right) \times 100\%$$

When $Y_T = 2Y_0$, T is defined as "doubling time".

So

$$T = \frac{\text{Log}\,2}{\text{Log}(1+R)}$$

For the number of US scientists represented by the entries in the AMS and AMWS, the calculation according to the above formula gives the following average annual growth rates and doubling times for different periods between 1906 and 1988.

Period	annual growth rate	doubling time (years)
1906-1927	5.8%	13
1928-1949	5.9%	13
1950-1973	4.5%	16
1974-1986	decline	n/a

The above results have confirmed that the accustomed exponential growth in S&T manpower in USA has not been able to continue since the 1970s.

Henderson used the membership figures of the Royal Society of Chemistry (RSC) as an indicator of scientific manpower growth in the UK during 1900 and 1987.(**Figure 4.4**)

A substantial increase in membership after 1972 is due to the inclusion of the Royal Society for Analytical Chemistry and the Faraday Society since then. So the growth rate from 1970 to 1980 is replaced by the rate of 1972-1987. For the UK scientists represented by the RSC membership, the average annual growth rates for different periods between 1900 and 1987 are summarised as follows:

Period	annual growth rate
1900-1910	3%
1910-1920	1.9%

1920-1930	0.3%
1930-1940	decline
1940-1950	8.5%
1950-1960	2.7%
1960-1970	4.4%
1972-1987	0

It is clear that in the 1940s, there was a rapid increase in the UK scientific manpower, followed by a slow down in the 1950s, then a rise in growth rate was found in the 1960s. Since 1972, there has been no growth in the number of RSC members.

The UK doubling time for the period 1900-1960 is about 27 years which is much longer than the USA figure(12.5 years) for the same period. One of the reasons for that may be due to the difference in the grades of the two sample groups of scientists. The RSC members might be more eminent than those in AMS and AMWS- this is only a guess. The other reason may be the difference in the growth rates of the two countries.

The Cabinet Office published an Annual Review of Government Funded R&D in 1990 which provides the most comprehensive statistic source on UK R&D development in the 1980s. In 1988-89, the total R&D employment in government was 43,685, of which 14,405 were at degree level. In 1988-89, the UK industrial R&D employment was 183,000 which was 4 times the government R&D manpower.

The government R&D employment (either in terms of civil R&D or total R&D) has been decreased slightly since 1987, this trend is estimated to be maintained until 1992. The UK industrial R&D manpower has fluctuated during the 1980s, with 195,000 in 1981, 186,000 in 1983, 173,000 in 1985, 188,000 in 1986, 185,000 in 1987 and 183,000 in 1988. Against the overall trend of stagnation in UK R&D manpower growth, the UK pharmaceutical industry R&D manpower has kept growing in the 1980s.

It is reported that the UK pharmaceutical industry employment has fallen steadily since 1985 at an average rate of 3.7% per year. However, R&D employment in UK pharmaceutical industry continues to expand, growing from around 12,300 in 1980 to 16,300 in 1989 with an average rate of 3.5% per year. In relation to the overall labour force of the industry, these figures corresponding to a rise from 15% to 23% during 1980-1989.

Since its modern inception in the early 1900s in China, S&T had grown slowly until P. R. China establishment in 1949. From 1950 to 1964 there was the first "golden period" of S&T during which China had produced its second generation of university graduates of one and half million which is seven times the total number of the first generation graduates (1911-1949), and built up thousands of S&T research institutions and a national S&T infrastructure which embraces most of important sciences or subjects in the world. The Cultural Revolution (1966-1976) had a devastating effect on China's science and technology. During this period, scientific work and university education came to a halt, only during 1972-1976 there were some two year courses in universities for training peasants, workers and soldiers. After that, China began rebuilding slowly, research capabilities were established again in the government, industry, and university sectors. Higher education was also restored with first enrolment of first degrees students in 1977, of master degrees students in 1978 and of doctoral degrees students in 1981 (Infor. China, 1989).

China official statistics on university students enrolment and graduates productivity enables us to draw lines showing the growth pattern of various degrees graduates representing the Chinese S&T manpower growth to some extent (**Figure 4.5 a&b**).

For comparison, the growth of UK degrees graduates is shown in **Figure 4.5c**. In general, the UK growth pattern is a smooth and stable one with a relatively lower annual growth rate- **1.96%** for first degree and **3.95%** for higher degree during the recent 13-years period of 1975-1988.

In contrast, the Chinese growth pattern is an erratic and unstable one with a relatively higher average annual growth rate - **15%** during the recent period of 1977-1985 for first degree graduates; **14.5%** for the master degrees during 1978-1987; **43%** for the doctoral degrees during 1981-1987.

Today the annual productivity of first degree graduates (over 300,000) in China is more than four times the figure in the UK (73,600), the annual productivity of higher degrees graduates in China (nearly 40,000) is 1.5 times the UK figure (28,700).

To view the growth in S&T employment in China is very difficult because of no annual statistics available before 1986. In 1986, China launched its first attempt to develop a science indicators database by conducting a national survey of S&T capabilities of government research institutions and by publishing a White Paper describing national S&T accomplishments and aspirations. Unfortunately, there are only figures for 1949, 1965 and 1985 available in the first national S&T White Paper (1987).

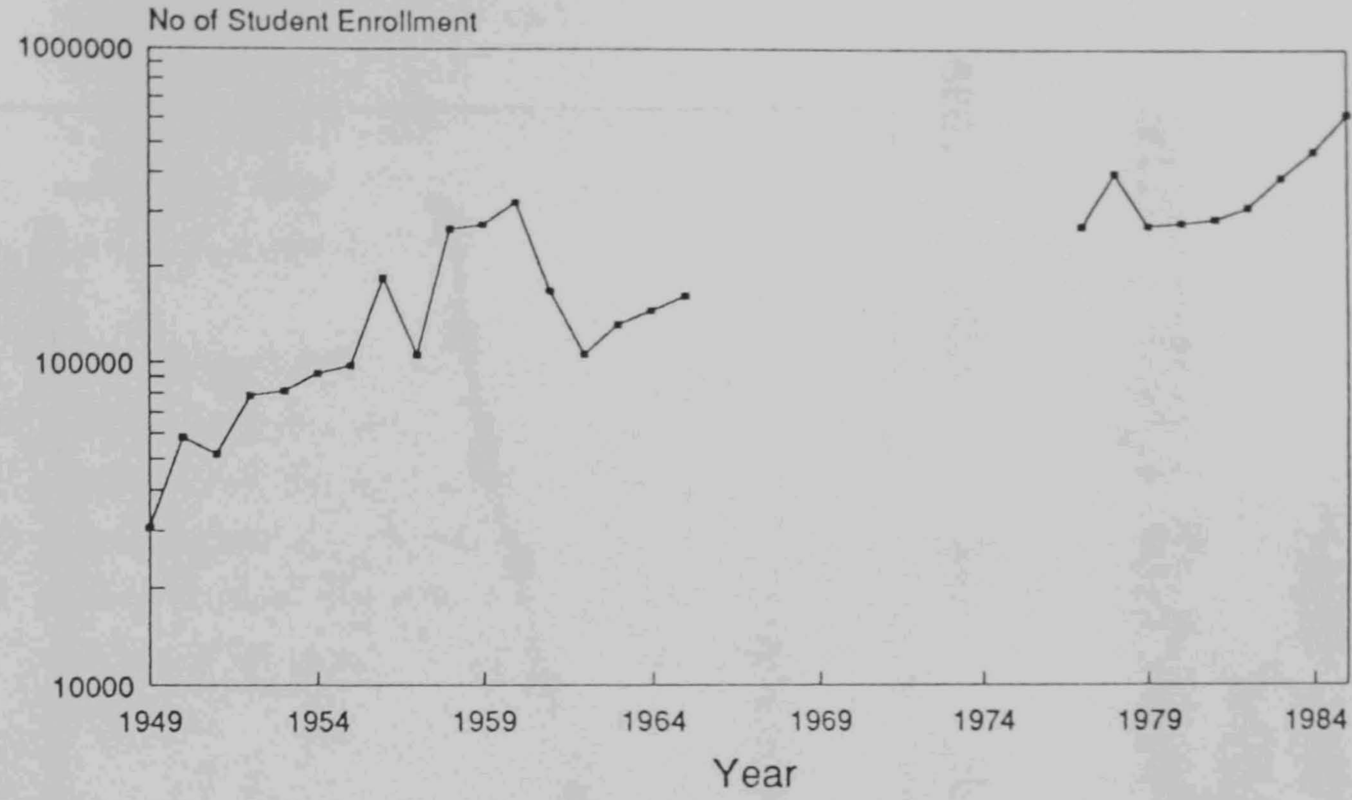


Fig. 4.5a Growth of First Degree Student
CHINA (1949-1985) (Info. China, 1989)

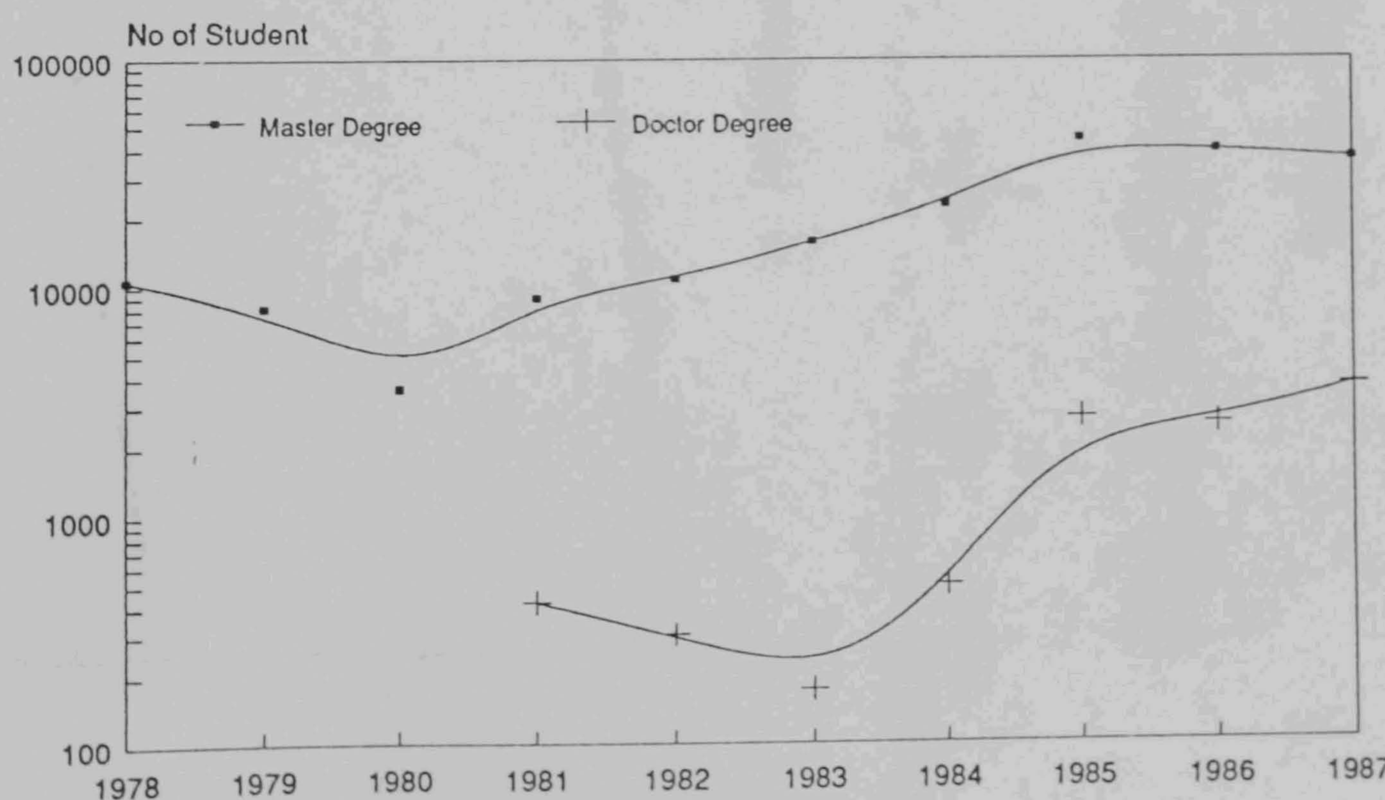


Fig. 4.5b Growth of Postgraduate
CHINA (1978-1987) (Zheng, 1989)

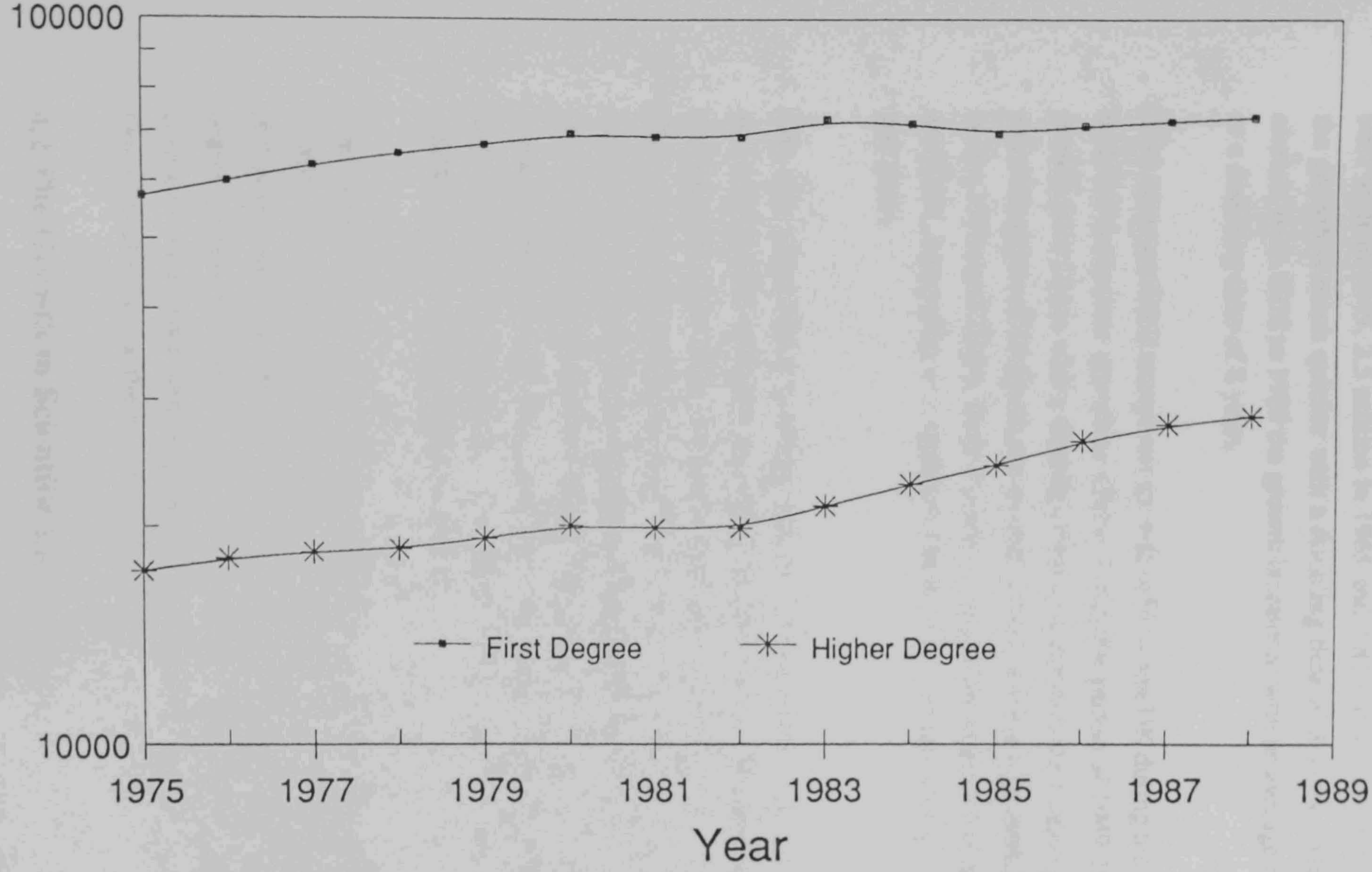


Fig. 4.5c Growth of University Graduate

U. K. (1975-1988)

(Univ. Funding Council, 1989)

According to the White Paper of the State S&T Commission (1987), there were 50,000 S&T staff in 1949, 2.5 million in 1965 and 7.81 million in 1985. From 1949 to 1965, the growth is much quicker with a doubling time of **3** years. After the Cultural Revolution, from 1978 to 1985 the growth is restored with an average rate of **9.4%** per year or a doubling time of **8** years.

If we compare R&D manpower growth in USA and UK during the period of 1900-1960 with the manpower growth in China during the period of 1949-1985, then the fastest growth is in China with a doubling time of **3-8 years,** the modest growth in USA with a doubling time of **12 years,** the slowest growth in UK with a doubling time of **27 years.** In the 1970s and 1980s, there has been a stagnation in R&D manpower growth in UK and USA, comparing to a rapid growth in China with an average growth rate of **9.4% per year.**

One may argue that to compare with the US scientists cited in the AMS and AMWS and with the UK scientists belonging to RSC, a more stringent measure is needed in choosing the same class of Chinese scientists rather than the total S&T manpower in China. The Academia Sinica (the Chinese Academy of Science) and several other special Academies, for example the Academy of Medical Sciences, the Academy of Agriculture etc., are ranked the first class research institutions in China. It is believed that the senior research scientists (e.g. those scientists at the grade I & II within the Chinese job hierarchy) in those academies are at the same class as the US scientists in the AMS and AMWS and the UK scientists in the RSC.

The number of senior Chinese scientists in the Academia Sinica rose from 200 in 1949 to 3000 in 1985 and 10,000 in 1989 (White Paper, 1990), which means a doubling time of 7 years and annual growth rate of 10.3% for the 40-year period. Even after choosing higher grade of Chinese scientists, the growth is still quite faster than the growth in the USA and much faster than the growth in the UK - with **12.5** year and **27** year of doubling time respectively (for the period 1900-1960).

4.2 The Growth in Scientific Literature

The Chemical Abstracts (CA) has been used by many bibliometric researchers for monitoring the world-wide literature growth, because of its comprehensive coverage in countries and in languages; and of its growth in proportion to the world literature. **Figure 4.6 and 4.7** show the growth of CA literature in the world, as well as in the USA and

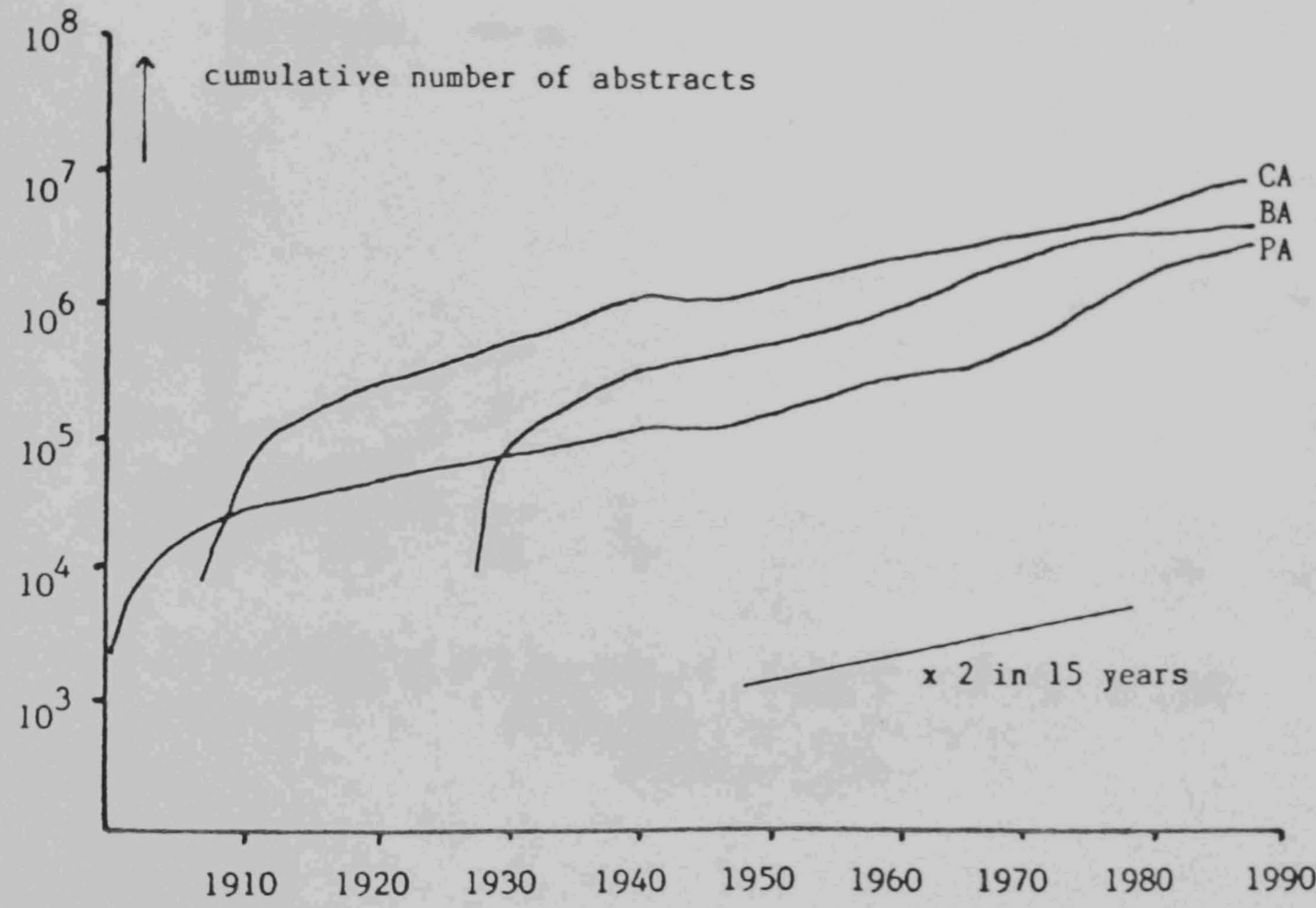


Fig 4.6 Cumulative number of entries in BA, CA and PA 1900 - 1987
(source from Henderson, 1988)

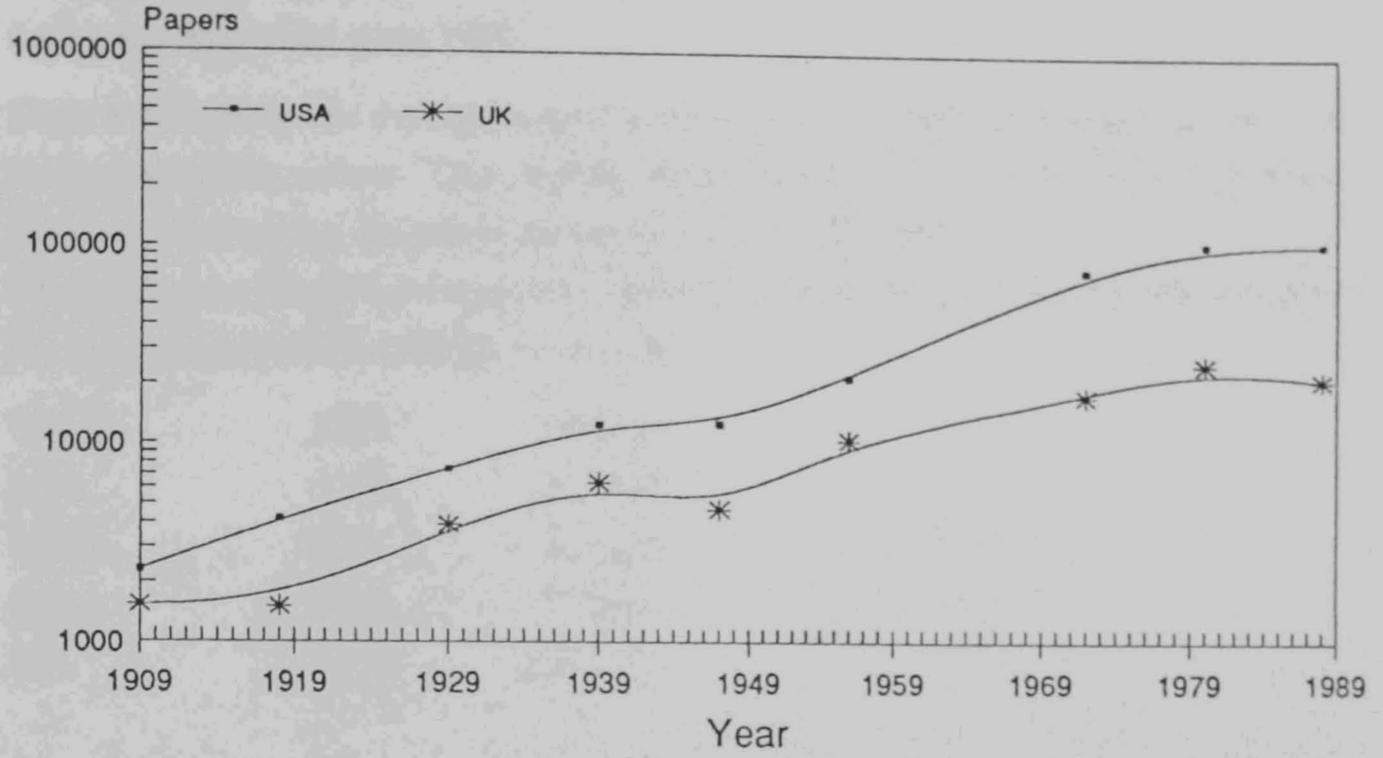


Fig. 4.7 Literature Growth in USA & UK
(1909-1988) shown by CA entries
(Henderson, 1988)

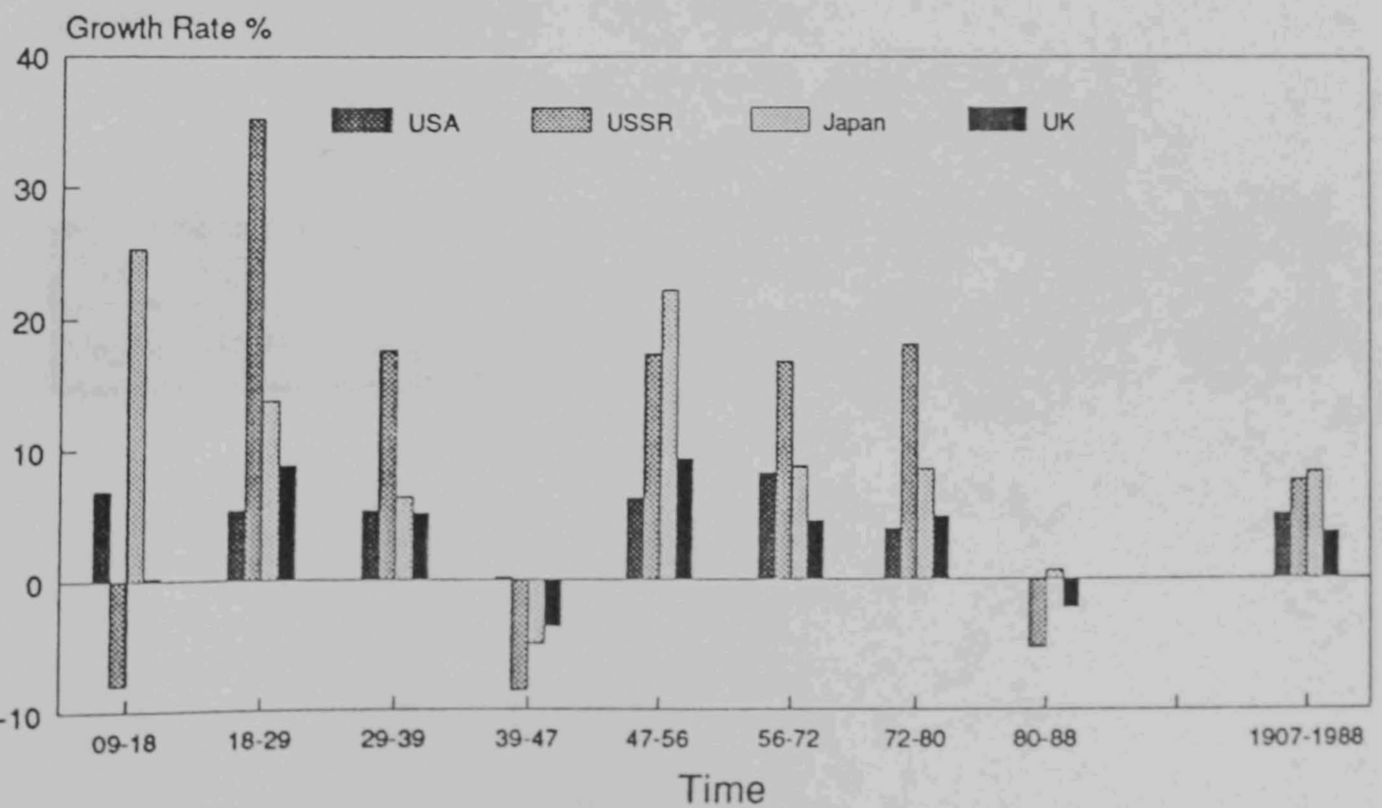


Fig. 4.8 Average Annual Growth Rates
represented by literature cited in CA

the UK. It is clear that after the War II, the world literature and the USA literature have grown very rapidly, followed by the stagnating period since the late 1970s. The UK literature in CA has grown at a relatively small rate after the War II, and seems also facing the stagnation since 1980.

Figure 4.8 shows the average annual growth rates for different periods for the four leading scientific nations- USA, USSR, Japan, and UK. All the countries except Japan have experienced the decline in literature growth since 1980.
Above all, the average annual growth rates and the doubling times for the four countries for the period of 1907-1988 are as follows:

World	5.0%	16 years
USA	5.0%	15 years
USSR	7.6%	10 years
Japan	8.2%	9 years
UK	3.6%	20 years

To monitor the growth of literature in China needs a Chinese abstracting or indexing journal equivalent to CA in terms of comprehensiveness. "China S&T Documentation Index" (CSTDI) published by ISTIC is regarded as the most comprehensive index journal in China. The growth of entries in Chinese Pharmaceutical Science in CSTDI for the period of 1983-1990 has been recorded in **Table 4.1**; which gives an average annual growth rate of **9%** and doubling time of **8 years.**

Table 4.1 Growth in Chinese Pharmaceutical Literature
-Entries in China S&T Documentation Index (1983-1990)

Year	1983	1984	1985	1986	1987	1988	1989	1990
Papers	3102	4342	3822	4630	4765	5156	4551	5212

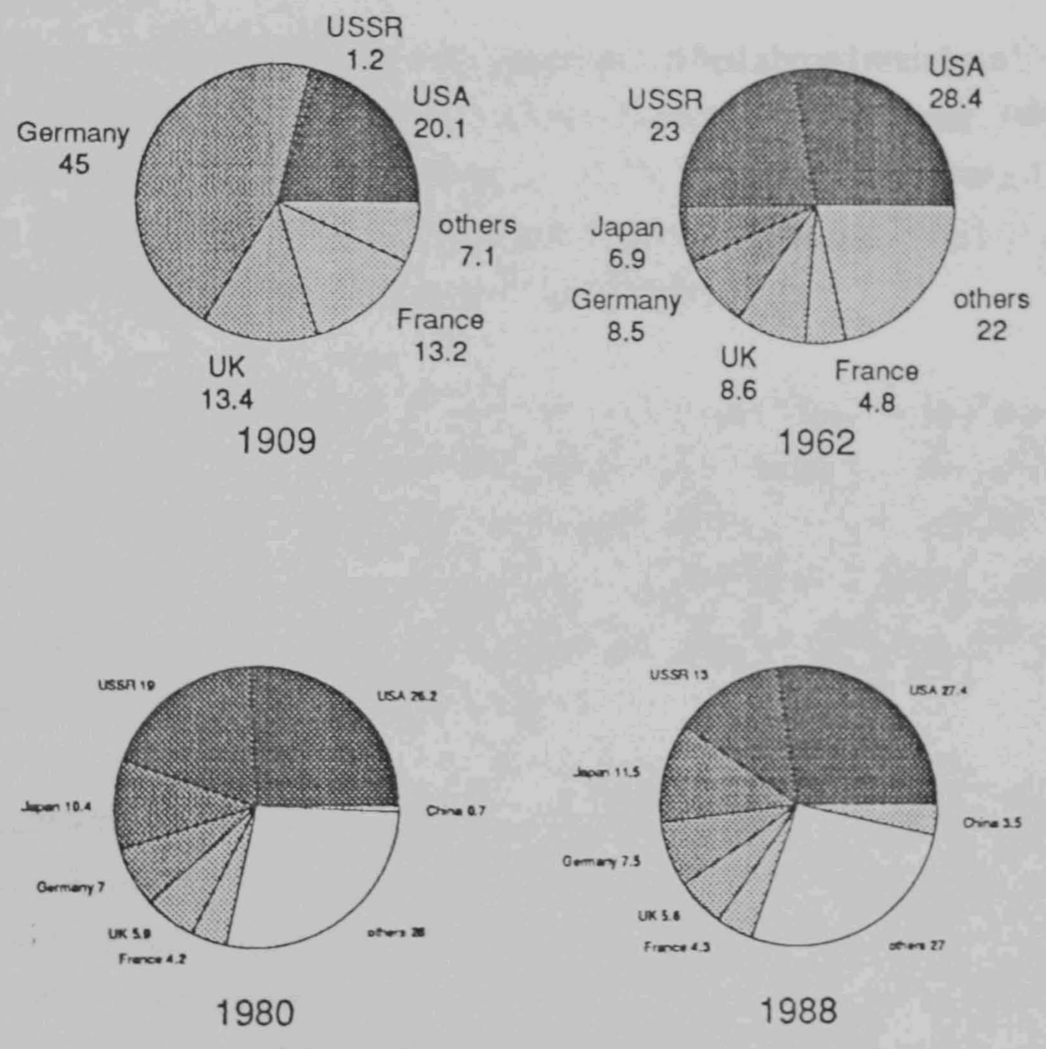


Fig. 4.9 Share of Journal Papers indexed in CA

as percentage of total journal papers

(source from Jhaveri, 1989)

In response to the restoration and growth in S&T in China after the Cultural Revolution, CA has increased the proportion of Chinese literature significantly since 1980 (**Figure 4.9**). In CA, the Chinese literature has grown at an average annual rate of **21.6%** from 1980-1988, or has a doubling time of **4** years; comparing to the decline in literature growth in most developed countries in the 1980s.

Like CSTDI, CA mainly reflects the S&T literature growth in China, because 98% of the Chinese entries in CA are in Chinese (Jhaveri, 1989). To measure Chinese literature in non-Chinese languages especially in English will show China's contribution to the world literature.

In 1986, there were 4566 Chinese S&T papers published abroad mainly in English which accounts for 9% of total Chinese S&T journal literature (White Paper, 1988). In 1988, the figure rose to 6647 which accounts for 12.9% of total Chinese journal literature in the year (White Paper, 1990). (The above figures include only S&T journal papers published by Chinese scientists in government institutes.)

Frame et al studied the growth of Chinese S&T literature in the world core journals covered by Science Citation Index (SCI) from 1973 to 1984. By using the constant set of 2300 world core S&T journals indexed in SCI since 1973 (less than one tenth of the total world journals), Frame had monitored the growth from only one Chinese paper in 1973 to 1000 in 1984. An exponential growth at an average rate of **87.4%** per year and a doubling time of **one** year (Frame, 1987).

Along this line, ISTIC has monitored the growth for the period of 1983-1989 (Zhang, 1990). **Table 4.2** shows the growth of all the Chinese papers (including Chinese authors as first authors and co-authors) appearing in the 1980s SCI journals. The figures show that in 1980s, Chinese S&T papers in SCI has kept growing at a high speed of **12% p.a.**. More significantly the number of Chinese papers appearing in foreign journals has grown even faster at an average annual rate of **17.6%**.

Table 4.2 Chinese Papers in SCI (1981-1989)*

Year	1983	1984	1985	1986	1987	1988	1989
No. of papers	3475	3714	3788	4349	4800	5590	6776
papers in ten Chinese journals in SCI	43%	41%	26%	26%	24%	21%	22%
papers in three thousands SCI non- Chinese journals	57%	59%	74%	74%	76%	79%	78%

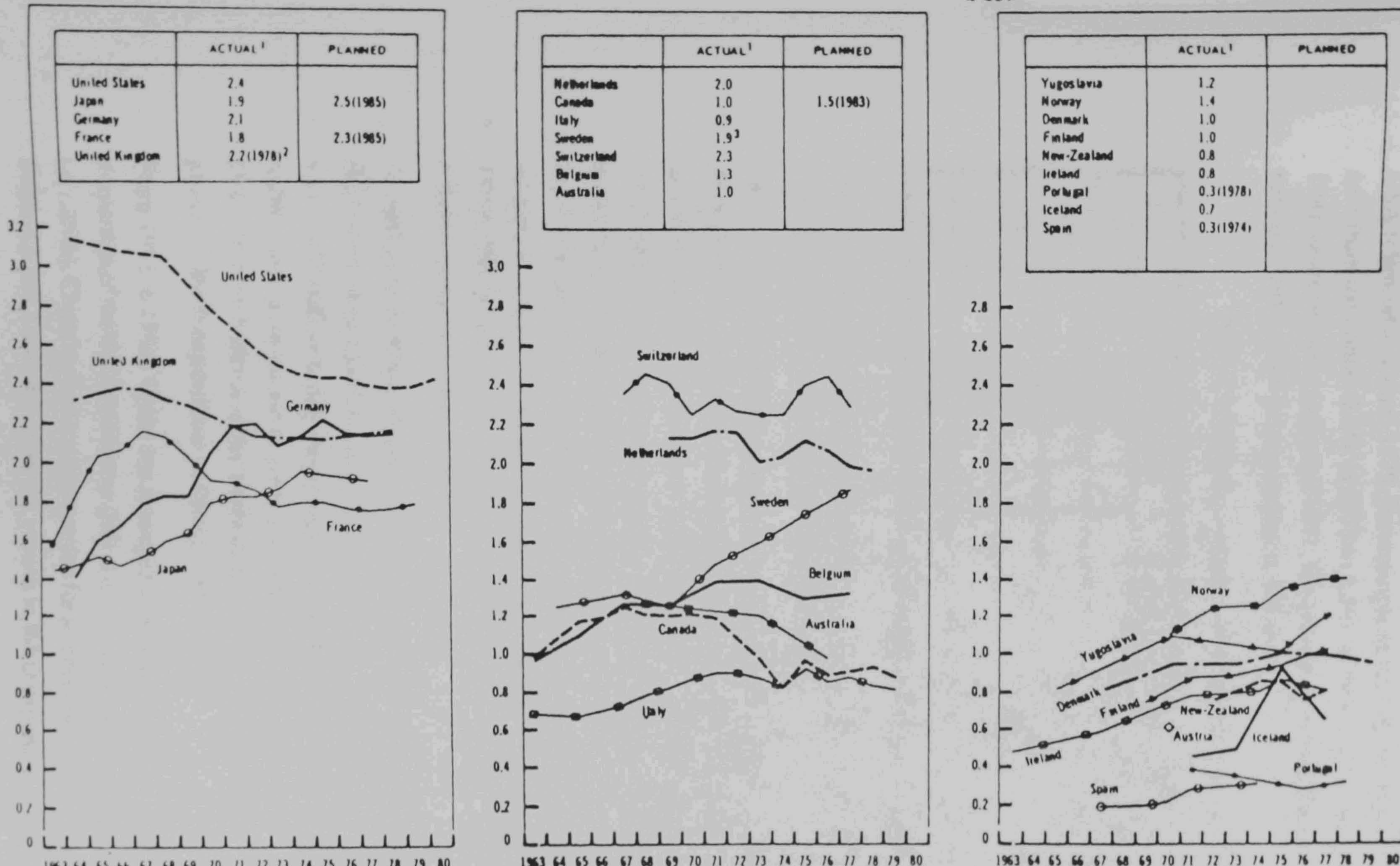
* In 1980s, SCI had increased its coverage of world core journals from two thousands in the 1970s to some what three thousands. Among the three thousands journals, there are apparently ten Chinese published English journals.

4.3 The Growth of Expenditure on Science

It is noticed that the significant growth in R&D expenditure as a fraction of the total GDP since the War II has commonly occurred in all the technologically advanced countries - USA, UK, USSR, France etc. For example, the figure in the USA rose from 0.3% GDP in 1940 to over 3% in 1964. So, of course, has the total amount of annual expenditure. Also taking the USA example, the total R&D expenditure rose from $0.5 billion in 1938 to $12 billion in 1962 (at constant price, using 1940s as a baseline). (Meadows, 1974)

In terms of R&D expenditure as a fraction of the total GDP, the USA reached the peak in 1964 at about **3.15%** and then declined steadily until 1978 at **2.4%**. The UK reached its peak in 1966 at about **2.4%** then declined until 1975 at **2.1%**(Fig. 4.10).

Because of the growth of GDP in the two countries over the period of 1966-1975, the R&D expenditure still increased in real term of money. For example, the UK R&D expenditure in 1966 was about £5.73 billion which rose to £6.20 billion in 1975 at constant price (using 1985 as a baseline). (International Monetary Found, 1989) That means an average annual growth rate of **0.9%** during 1966 and 1975.



1. Level in 1977. 2. OECD (STIU) estimate. 3. Excluding Social Sciences and humanities.

Fig 4.10 Domestic R&D Expenditure as a percentage GDP

(source from OECD/STIU Data Bank (end 1980))

Since 1976, the UK has gradually speeded up the growth rate of R&D expenditure. The USA followed suit since 1979. For example in the UK, the R&D as a fraction of GDP rose from the bottom **2.1%** in 1975 to **2.2%** in 1978 (Fig. 4.10); then rose to **2.3%** in 1981 which has been kept until 1987. The growth in the UK R&D expenditure over the period of 1981-1987 is summarised in **Table 4.3**:

Table 4.3 R&D Expenditure in the UK (*Britain 1980-1990*)

Year	R&D (£) million	R&D (£) million at 1985 price	% GDP
1981	5800	7334	2.3
1983	6700	8719	2.6
1985	7900	7900	2.2
1986	8800	8423	2.3
1987	9500	8785	2.3

The UK R&D expenditure has grown at an average annual rate of **2.9%** from 1975 to 1987. (at constant price, using 1985 as a baseline)

About 50% of UK R&D expenditure was provided by industry, 39% by the government (Britain 1990). The British Pharmaceutical Industry is a leading industry in the country and in the world with the largest R&D investment. In 1989, its R&D expenditure was over £800 million, amounting to more than 10% of all manufacturing industry R&D spending in UK (Britain 1991). The R&D expenditure has increased by **61.7%** during the 5-year period of 1982-1987 in real term; comparing to the increase of **36%** in the whole UK industry for the same period (Annual Review on Government Founded R&D 1990). That also means an average annual growth rate of **10%** in UK pharmaceutical R&D investment (Lumley, 1989).

According to the White Paper of the State Science and Technology Commission in 1986, R&D expenditure in China has been grown substantially since 1949. The total amount was ¥1437 million during the period of first five year plan (1953-1957), reached ¥33278 million during the period of sixth five year plan (1979-1983), increasing by 23 times. Or in real term it increased by **18 times** (using 1985 as a baseline). **Table 4.4** shows the growth in R&D expenditure in China (1953-1983).

From 1953 to 1983, China has managed to maintain its R&D expenditure as a certain proportion of the National Income (NI) at over 1.61%, except for the period of 1966-1970 (at 1.36%). China has had a golden period for science and technology during 1977-1984. **Table 4.5** and **Table 4.6** show the growth in R&D expenditure in China (1977-1988).

Table 4.4 R&D Expenditure in China (1953-1983)- (White Paper, 1986 & International Monetary Found, 1989)

Period	R&D (¥) in million	NI* (¥) in million	% NI**
1953-1957	1437		
1958-1962	9742		
1963-1965	7005	335.3	1.97
1966-1970	10,932	803.1	1.36
1971-1975	18,333	1138.2	1.61
1976-1980	26,050	1511.9	1.72
1979-1983	33,278	1996.9	1.67

* not correcting for inflation

** figures only include R&D expenditure in government institutes.

Table 4.5 R&D Expenditure in China (1977-1988)- (White Paper, 1987-1990 & International Monetary Found, 1989)

year	R&D (¥) million	growth rate per year	NI* (¥) billion	%NI**
1977	4148		264.4	1.57
1978	5289	27.5%	301.0	1.76
1979	6229	17.8%	335.0	1.86
1980	6459	3.7%	368.8	1.75
1981	6158	-5%	394.0	1.56
1982	6529	6%	426.1	1.53
1983	7903	21%	473.0	1.67
1984	9501	20%	565.0	1.68
1985	n/a			
1986	11150		788.7	1.41
1987	10847	-3%	932.1	1.17
1988	13324	22.8%	1254	1.06

* not correcting for inflation

** figures only include R&D expenditure in government institutes

Table 4.6 The Growth Rate of R&D Expenditure and the Inflation Rate in China for 1978-1988

Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
growth rate %	27.5	17.8	3.7	-5	6	21	20			-3	22.8
inflation rate* %	0.7	1.9	7.5	2.5	2	2	2.7	11.9	7	8.8	27

*(Hartland-Thunberg, 1990)

The average growth rate of Chinese R&D expenditure for the period of 1977-1984 is 13% per year. After correcting for inflation rate (average rate for the same period is 2.7% per year (International Monetary Found, 1989 & Hartland-Thunberg, 1990)), the real growth rate for Chinese S&T expenditure is **10.3%** per year. It is quite rapid, comparing to the UK rate of **2.9%** during 1975-1987(in real term, using 1985 as a baseline).

However, since 1985, the growth of Chinese S&T expenditure has been greatly held back. In 1987, the annual reduce of S&T expenditure was 3%. After correcting for inflation, the annual decrease was 11.8%. In 1988, the annual growth was 22.8%. After correcting for inflation, it decreased by 4.2%.

From Table 4.5, it can also be found that since 1984, the ratio of S&T expenditure to National Income (NI) has declined steadily from 1.68% in 1984 to 1.06% in 1988. On the whole, Chinese S&T finance situation is under severe constraints now.

4.4 Impacts on the Chinese Scientific Communication

Science and its communication are always inextricably bound together, so that the production and the dissemination of the results of research go hand in hand. The rapid growth of science for the last three centuries has on one hand greatly accelerated the development and enhancement of the complex of information channels and sources, and on the other hand has been changing scientists' communication behaviour.

4.4.1 Impact on Formal Scientific Communication

Today scientific communication formally go through learned journals, books, reports, and patents etc..

Currently one of major impacts of scientific growth on scientific communication in the developed countries comes from the fast increasing amount of scientific literature in the developing countries and the difficulty in accessing them because of the language barrier (Jhaveri, 1989). Although certain proportion of pharmaceutical scientists in Britain are aware of the value of foreign information and the language barrier, what they have noticed is the existence of S&T information in German, French, Japanese (Thorp, 1987). There is little doubt that the scientists in the developed countries like UK have difficulty in getting aware of and access to the Chinese S&T information, since of which only 4% are in English, only 15% are covered by CA (See Chapters 3 and 6).

The world-wide exponential growth of science mainly has impacts on scientific communication in China.

Firstly, like many developing countries China has very limited hard currency to purchase foreign S&T journals. Today there are as many as 850,000 S&T papers per year adding into the world literature pool (Price, 1986 & Martyn, 1979). The estimate of the number of current journals in the world, based on the holdings and the titles on order at National Lending Library in UK in December 1965, was 26,000 (Martyn, 1979). This number has risen to 55,000 by 1990 (BLDSC Figures, 1989-1990). Facing such an "information explosion", the S&T information system in China has some problems in collecting and disseminating the world S&T literature effectively to its 7.8 million S&T manpower. When China opened the door to the world in the late 1970s, it found itself facing a very expensive world information market and the ever increasing prices of the world S&T literature.

From 1974 to 1979, the average journal price rose by **120%** in UK (Royal Society, 1981). From 1980 to 1990, the world scientific journal price rose by **245%** (Enright, 1990). The combination of the proliferation of journals and the inflation of journal price world-wide has greatly limited the S&T information reserve in China.

Secondly, because of the last four decades exponential growth in S&T manpower, there are not enough S&T journals for scientists to publish papers in China. Unlike in the western countries, there are no commercial S&T journal publishers in China, because of very low or no profit in S&T journal publishing. About 30% of journals are published by universities, 24.5% by learned societies, 35.6% by government departments, and 6.8% by Chinese Academy of Science (White Paper, 1987). Partly due to the above reason, there are not enough journals for millions of Chinese scientific and technological workers to publish papers. There are only some 3000 S&T journals in China against 7.8 million S&T workers; by comparison there are some 4,000 scientific journals in UK against 0.2 million S&T workers (see Chapter 6).

Additionally, mainly owing to language barrier, China has had difficulty in disseminating Chinese S&T information into the world through its very small number of English language journals (less than 70 titles, according to Infor China, 1989).

Furthermore, the existing Chinese national secondary publication system is not comprehensive to cover the ever increasing Chinese S&T literature. All these problems will be further discussed in Chapter 8.

4.4.2 The Changing Informal Communication Pattern

Studies of UK and USA scientific communication pattern suggest that urgent dissemination usually pass through informal or less formal channels, such as "invisible colleges" and conferences etc.. (Garvey, 1972 & Royal Society, 1981).

The discussion about invisible colleges in science or informal scientific communication has been lasting for thirty years. Derek Price (1963) has estimated the number of people with whom a good scientist can exchange reprints, preprints and professional correspondence, and with whom he can perhaps collaborate at a reasonable and comprehensive level. His guess is that there are a few hundred colleagues for every worker. In his book " Little Science, Big Science", Price described:

"The first noteworthy phenomenon of human engineering is that new groups of scientists emerge, groups composed of our maximal 100 colleagues. In the beginning, when no more than this number existed in a country, they could compose themselves as the Royal Society or the American Philosophical Society. At a later stage, they could split into specialist societies of this size. Now, even the smallest branches of subject matter tend to exceed such membership*, and the major groups contain tens and hundreds of thousands. In a group of such size, by our previous analysis, there are likely to be a few groups of magnitude 100, each containing a set of interacting leaders".*

Price suggested "such groups constitute an invisible college".

Such an invisible college can effectively solve a communication crisis by reducing a large group to a small select one of the maximum size that can be handled by interpersonal relationships - exchange of preprints and reprints, personal contacts and conferences. In the West, it is said that the above "invisible college" has a history of three hundred years and has changed little ever since.

Garvey has described S&T communication through conferences as follows:

"As the process of scientific communication has grown longer and more complicated in recent years, the national meeting has developed a distinct and increasingly important function in the overall communication process. Nowadays the national meeting integrates into this total process in such a way as to usually constitute both the first major occasion for early dissemination of scientific work and the last major informal medium before such work becomes temporarily obscured from the public during the relatively long period between first submission of manuscripts and their eventual journal publication.

"Much of the scientific information exchange behaviour is intrinsically exploratory- i.e. few participants attend meetings with a plan of what information they will seek there or of how they will go about assimilating information there.

"Especially younger scientists rely heavily on the national meeting to obtain new information from the informal networks. More experienced scientists, because of their prominence in the field, find this new information readily accessible to them" (Garvey, 1972).

Price and Garvey had described informal communication based on the USA situation. We may assume that the description also applies to UK since the two countries both belong to the most advanced scientific nations in the world, both have a common cultural origin and use the same language.

Whether there is a similar informal communication pattern existing in China has not been much studied. Since many users studies suggest that 90% of Chinese scientists greatly rely on foreign literature and most senior Chinese scientists mainly use foreign S&T information in their research work (please see the next chapter); we feel that it is more important to ask whether and to what extent Chinese scientists take part in informal communication network internationally.

Chinese scientists face two kinds of information communication circuits - native language communication circuit and foreign language communication circuit. A scientist is spontaneously at his native language communication circuit. However, he might or might not be involved in foreign language communication circuits, depending on current communication relationship between China and other countries and on his language ability as well.

In 1890, first big group of 120 Chinese students were sent abroad to study modern S&T by the last feudal empire "Qing". Since then until 1949, there had been a certain number of Chinese scholars being educated abroad. About one thousand of them return back to China in the early 1950s. They constitute the "first generation" of overseas Chinese scholars. Today some of them at their seventies are still actively involved in Chinese S&T activities and higher degrees education. (Chinese Scholar Abroad, No. 1 1991)

Since 1949 along with the rapid growth in S&T nationwide, China has experienced an uneven progress in international scientific communication- from the 1950s' scientific communication mainly with Soviet Union and some Eastern European countries, followed by the 1960s' and 1970s' isolation from the outside world, to today's proliferation of international communication activities with most of the world developed countries. From 1950 to 1965, China has sent some **10,000** university students and postgraduate students to East Europe, among them 80% went to Soviet Union. About 95% of the students returned back to China after the education abroad.

From 1978 to 1990, some **40,000** postgraduate students and visiting scholars have returned to China after their education abroad. By 1990, there are other **60,000 students and scholars** studying abroad and being sponsored by the government; while the number of mainland students and scholars abroad in 1985 was **30,000** (Chinese Scholars Abroad, No. 1, 1991 & Howe, 1987). The number of overseas students and scholars from mainland China has **doubled during five years**.

Here we use the example of Chinese Academy of Sciences to demonstrate the progress in international scientific communication.

From 1979 to 1988, the total number of exchange scholars in Academia Sinica was **36,000**- half are Chinese outflowing and half are foreigners flowing into China. A growth from 1860 in 1979, to 2520 in 1984, and to 6800 in 1988. Apart from the above exchanges for short time communication, there have been **3,000** senior research scientists or engineers from Academia Sinica working in academic institutions in many advanced countries for longer term (six months or more). These three thousand people account for one third of total senior S&T staff with first or second job grade (see §3.3) in Academia Sinica.

From 1978 to 1988 Academia Sinica alone has sent out **6,300** visiting scholars and postgraduate students to study abroad which almost totalled the national number of overseas Chinese students sent out by the government for the previous thirty years (1949-1977) (Bureau of International Cooperation in Academia Sinica, 1989).

The number of Chinese scientists attending international meetings and conferences has also increased greatly. In *Index of Scientific and Technological Proceedings (ISTP)*, Chinese scientists' papers has increased from 918 in 1985 to 2139 in 1989. The figure doubled in five year time. The figures from 1985-1989 are: 918, 1617, 2278, 3214, 2139 (Zhang, 1990). For Academia Sinica alone, the number of Chinese scientists attending international meetings abroad rose from 280 in 1979, to 580 in

1984, to 1000 in 1988. Furthermore, for the past ten years, Academia Sinica has held around one hundred international meetings in China. In 1987 alone, Academia Sinica held 30 such meetings (Bureau of International Cooperation in Academia Sinica, 1989).

Nowadays, the world scientific community started to see more and more Chinese scientists joining S&T performance and playing more and more important roles in the world stage. Twenty scientists from Academia Sinica have been elected as major leaders in international academic organizations. One hundred scientists from Academia Sinica have been invited as visiting professors or awarded honour S&T titles by academic institutions in other countries (Bureau of International Cooperation in Academia Sinica, 1989).

There have been two major trends in the growth of science in China since 1978 - the high tide of scholars and students going abroad for education; and the massive inflow of foreign scientists both for communication and lecturing.

All the above facts and figures have shown that today Chinese scientists have taken part in informal communication world-wide much more than ever before; though their impact on the world is still quite small (see Chapter 6), though few of them are regarded as leaders in the world "invisible colleges".

Bearing in mind that there have already been 40,000 scholars finished their education abroad and returned back to China for the last ten years, and that there are apparently 60,000 studying in the developed countries, within years, they will enter the front of the world S&T. This new generation of Chinese scientists will greatly change scientific communication pattern in the world by increasing the proportion of Chinese papers in the world journals and by adding more Chinese scientists into the world "invisible colleges" and the world scientific conferences.

4.5 Concluding Notes

The S&T manpower in USA has grown at an average rate of 6% p.a. with a doubling time of 12 years for 1900-1960. Since the late 1960s stagnation has been reached and maintained until now. The S&T manpower in UK has grown at a relatively low speed for 1900-1960 with a doubling time of 27 years. Also stagnation has been found in the early 1970s and kept until now.

Although modern S&T was introduced into China late in the first half of the century, its boom had not started until 1950. From 1949 to 1989, S&T manpower in China has been growing at an average rate of some 10% p.a. with a doubling time of 7 years.

As a result of the growth in S&T manpower, by 1987 China has an annual productivity of 300,000 first degree graduates, which is 4 times the UK figure; of 40,000 higher degrees graduates which is 1.5 times the UK figure. By 1985, there are 7.8 million S&T manpower in China with degree holders or equivalents accounting for 40% of total. In 1988, there is a S&T manpower of 227,000 in UK with degree holders and equivalents accounting for one third.

In contrast to the overall decline trend or stagnation in R&D employment in the 1980s in the UK, the British pharmaceutical industry has maintained a substantial growth in R&D employment at an average rate of 3.5% p.a. and has risen the R&D proportion in its whole labour force from 15% in 1980 to 23% in 1989.

Referring to CA, after the World War II, the US literature has grown rapidly followed by a stagnation since the late 1970s. The doubling time for US literature is 15 years for 1907-1988. After the World War II, the UK literature has grown at a relatively low speed, and seemed also facing stagnation since 1980. The doubling time for UK literature is 20 years for 1907-1988.

After the Cultural Revolution (1966-1976), S&T literature in China has experienced a rapid growth. Pharmaceutical literature as indexed in CSTDI, for example, has grown at an average rate of 9% p.a. or a double time of 7 years for the period of 1983-1990.

Perhaps more significant growth in Chinese S&T literature in the 1980s have been recorded in CA, SCI and other international secondary publications. In CA, the Chinese literature has grown at an average rate of 21.6% p.a. for 1980-1988. That has risen the Chinese proportion of the world literature from 0.7% in 1980 to 3.5% in 1988; comparing to the reduce trend in UK ratio from 5.9% in 1980 to 5.6% in 1988.

Using SCI to monitor Chinese literature growth in the three thousand of the world core journals, a rapid growth was found from one Chinese paper in 1973 to 1000 papers in 1984 with an average growth rate of 88% p.a. Following that rapid growth, from 1983 to 1989, Chinese literature in the world core journals continues to grow with an average rate of 12% p.a.

It is noticed that the significant growth in R&D expenditure as a fraction of GDP since the World War II has commonly occurred in all developed countries from less than 1% before the war to some 2-3% by the mid 1960s. After this rapid increase in R&D

expenditure, there has been a stagnation in the growth of R&D as proportion of GDP in UK and other developed countries. In UK the R&D as the proportion of GDP has been fluctuating between 2.1% and 2.3% since the mid 1960s.

In real terms, the UK R&D expenditure has grown at an average rate of 2.9% p.a. from 1975 to 1987. The UK pharmaceutical industry is a leading industry with the most heavy R&D investment in the UK and in the world. The UK pharmaceutical industry R&D expenditure has increased by 61.7% for 1982-1987 while the increase in the whole UK industry for the same period is 36%. The UK pharmaceutical industry R&D expenditure has grown at an average rate of 10% p.a. in the 1980s, comparing to 2.9% p.a. in the whole UK R&D expenditure in the 1980s.

From 1953 to 1983, the R&D expenditure in China has increased by 18 times in real term. During the period, China has maintained its R&D as a proportion of National Income at the level of 1.61%.

From 1977 to 1984, a growth in R&D in China has been made with an average rate of 10.3% p.a. in real term; comparing to 2.9% p.a. in UK for 1975-1987.

However, since 1985, a stagnation in R&D expenditure has been found in China. In 1987 and 1988, the R&D expenditure has fallen by 11.8% and 4.2% respectively in real term.

Moreover, since 1984, the R&D ratio as proportion of National Income (NI) in China has declined steadily from 1.68% in 1984 to 1.06% in 1988.

It is noted that UK pharmaceutical industry has maintained a steady growth in R&D manpower and expenditure against the overall stagnation in UK in the 1980s and in China since 1985. The implications include:

1. The growth of science (or R&D) depends on the economic capacity of a country or an industry.

2. The worldwide scientific growth has a positive impact on Chinese scientific communication by increasing the proportion of Chinese papers in the world, and by adding more Chinese scientists into the world scientific communication.

3. The worldwide scientific growth has a negative impact on Chinese scientific communication through costs and information inflation, by increasing the dependence of China on foreign S&T information which is greatly obstructed by language barriers and foreign currency shortages.

4. In China, the growth of scientific manpower should be parallelled by the growth in the Chinese publishing industry and secondary information services.

Chapter 5 Scientists' Information Needs Searching and Accessing Ability

5.1 Introduction

Information user satisfaction is subjective and hard to define, but the attitudes of the users to an information system is always of primary importance in "measuring" the performance of scientific information flow in a country. This information users' study will provide some evidences for planning the reform of the Chinese S&T information flow in Chapter 9.

Results from six surveys are analysed to compare the situation in the UK and China. Although the six surveys were conducted in different period of the 1980s and were using different sampling methods, they all looked at scientists' information needs, searching and acquiring habits with the following common features:

1. Good coverage of the area; of the six surveys, two are British nationwide surveys and one is the Chinese national survey;

2. Good coverage of the pharmaceutical subject; four of the six surveys are with particular concern on pharmaceutical sciences;

3. Representative of various kinds of scientists; the British surveys distinguish between academic, industrial and government scientists whereas the Chinese surveys focus on scientists in academic institutes where most of high standard R&D take place; because 65% of R&D is performed in industry in the UK whereas 70% of R&D is in academic institutions in China (see Chapter 3).

A summary of the six surveys is given as follows:

Survey 1. A Study of the Scientific Information System in the UK (nationwide survey)

conducted by - Royal Society

period covered - 1981

subjects - scientists from a range of subjects and types of employers responses - 592 (rate : 63%)

sampling method - An attitude questionnaire was sent to four groups of scientists: biological scientists in research institutes and university departments in Aberdeen; physical scientists in the University of Oxford; physical scientists at the National Physical Laboratory; and biologists, biochemists and chemists at ICI pharmaceutical division.

Comment - There is very good reason to believe that the survey reflected reasonably representative of pure scientists' view in the early 1980s in the UK. The survey is extremely valuable in that it included a case survey on pharmaceutical scientists at ICI pharmaceutical division. In the following study, only data on Oxford chemists and ICI chemists will be used.

Survey 2. Literature Searching Habits and Attitudes of Research Scientists (nationwide survey)

conducted by - John Martyn, Aslib

period covered - 1986

subject - academic, industrial and government scientists in the UK.

responses - 266 (rate: 35%)

sampling method - 450 academic scientists were drawn from the "Research in British Universities, Polytechnics and Colleges", and 183 responded (rate: 41%). 100 government scientists and 200 industrial scientists were selected from SCI 1985 edition, 30 responses from government (rate: 30%) and 53 from industry (rate: 26.5%).

comment - This is a national survey of scientists' searching habits and attitudes. Since the early 1980s, there have been many changes in the information sector, including the popularization of online searching, large scale automation of library and information service, e-mail, viewdata etc., the survey of 1986 with supplement of the other latest ones (Howorth, 1988; Byway, 1988) may reflect the changes in searching behaviour along with the changes in the information environment during 1980s.

Survey 3. The Foreign Language Barrier: a study among pharmaceutical research workers

conducted by - R G Thorp et al.

Period covered - 1987

subjects - all research scientists requiring information in Pfizer pharmaceutical company (UK)

responses - 58 (rate: 94%)

sampling method - A questionnaire was sent out to all scientists requesting literature searches or similar services during a week period at Pfizer Central Research (UK). A total of 62 forms was handed out, of which 58 were returned. This represents about a quarter of the research scientists at Pfizer.

Comment - It was noticed in the Royal Society survey (1981) that the greater attention to foreign language information by chemists at ICI than by other groups of scientists. The latest survey gives a more clear picture of pharmaceutical scientists' performance in foreign language information communication.

Survey 4. A National Survey of Scientists' Information Needs and Uses in China

conducted by - ISTIC

period covered - 1981

subjects - scientists from a wide range of subjects in China

responses - 1840 (rate: 23%)

sampling method - 8,000 questionnaire forms were sent out to scientists at 440 academic institutions in 20 provinces of China. 1840 returned (rate: 23%).

comment - It is the most comprehensive survey which has ever been conducted in China. However it has the weakness of not distinguishing between subject areas.

Survey 5. A Survey of Medical and Pharmaceutical Scientists' Information Needs and Usage in the Tianjin City

conducted by - Tianjin Medical Information Institute

period covered - 1988

subjects - medical and pharmaceutical scientists in the Tianjin City

responses - 182 (rate: 61%)

sampling method - 300 forms were sent out to scientists at 29 medical and pharmaceutical research institutes in the Tianjin City. 182 were returned (rate: 61%).

comment - The Tianjin City is one of the three large municipalities in China and is also one of the most important pharmaceutical R&D bases in the country. It is felt that where all these scientists agree, we may regard their view as reasonably representative of scientists in pharmaceutical sciences in big cities in China.

Survey 6. A Survey of Pharmaceutical Scientists' Information Needs and Usage in Beijing and Shanghai[9]

conducted by - B. Chen

period covered - 1989

subjects - pharmaceutical scientists in Beijing and Shanghai

responses - 56 (rate: 56%)

sampling method - 100 forms were distributed to scientists who were searching for information at four pharmaceutical research institute libraries (two in Beijing and two in Shanghai) during one week period. 56 returned (rate: 56%).

9 A sample of the questionnaire used in this survey is in Appendix 5.3.

comment - Together with the survey of the Tianjin City, this latest survey try to draw a picture of information needs and usage by pharmaceutical scientists in the three biggest cities (municipalities) in China. Because of the small sample size of this survey, no claim is made for statistical significance and the findings can only be indicative. Questionnaire survey was not widely used in China until the late 1980s. Chinese scientists tend to give low response in surveys. Being aware of that, the author distributed all forms in person in order to get a better response.

5.2 Information Needs and Need Satisfaction

From an information scientist's point of view, scientific research is like a spiral procedure of stimulating information needs, searching for information, older information needs being satisfied and new information needs being generated, then a new information searching cycle starting, and so on and so forth. This spiral procedure is not repeating at the same level of information needs but rising from lower level to higher level all the time. In other words, as the spiral procedure continues, scientist's information needs change from general status to more specific status, from ambiguous to clearer. Gradually, the more cycles a scientist processes, the higher level of information needs get satisfied, the nearer he is approaching the goal of his research work.

As a scientist is seeking to maintain his work at the cutting edge of science, he constantly seeks new, viable information- namely, information which he needs to place his work in context with similar work recently completed- so his own work will not be passe' by the time it is completed.

Generally, scientific information needs fall essentially into three categories:

1. Current awareness of ongoing R&D projects,
2. Retrospective searching for accomplished projects,
3. Day to day data or factual information consulting.

During the early stages of any research, the scientist especially needs information to aid in perception of his problem and in formulation of procedures appropriate to his inquiry. Here both current awareness and retrospective searching are needed.

In the intermediate stages, his information needs become more specific, for example, details of techniques and methods, day to day information consulting are needed.

In the final stages his needs shift to the general body of knowledge as he seeks to fully interpret his data and integrate his findings into the current state of knowledge.

Above all, the spiral procedure of information need/satisfaction is an essential part of scientific research. Whether or not such an information spiral procedure can be built up properly in a scientific research will determine the success and the quality of the work.

5.3 Scientists' Information Searching and Accessing Ability

5.3.1 How do scientists keep aware of current progress in their fields

Before initiating a R&D project, research scientists need to know what is happening in their relevant fields or specialities, where are things happening, and conducted by whom?

Throughout all stages of R&D, they also constantly seek new, viable information, so their work will be in proper context with other current work in the fields.

To avoid unwarranted duplication of research effort is another reason for scientists to keep aware of current progress. However to keep aware of current progress is very difficult for ordinary scientists especially those in the developing countries.

A scientist discusses his work rarely in the first one or two years. After he has reached the stage at which he feels prepared to give a complete report, he begins disseminating his findings within his immediate environment and to a very small group of outside workers normally those prominent scientists in the fields. So far, for all practical purposes, information about the early stages of a R&D work is inaccessible to the public scientific community. Being aware of current progress in the earlier stages is a privilege of very few prominent scientists or leaders in "invisible colleges". For ordinary scientists, there are three channels through which they could get the current progress information.

The first channel is *current research information system.*

"The current research information is characterized as a standardized set of scientific, technical and administrative data which describe research projects about to be initiated, actually in progress, or recently completed.

"The general survey conducted by UNESCO and SSIE showed that there had been an increasing interest in the field of transfer of information on ongoing research.

"By 1982, there were already 230 planned, pilot and operational systems in 67 countries in the world" (Lei, 1988).

The most known systems includes SSIE (1949-) in USA which annually registers 150,000 projects by 1300 governmental or non-governmental organizations; and Current Research in Britain (1985-) which is the national register of current research being carried out in universities and other institutions in UK.

This sort of current information systems, however, has the difficulty in control of non-governmental information source especially industrial source. Because of the need of intellectual property protection, in pharmaceutical R&D, the first chance for scientists to publish their findings is after new chemical compounds having been protected by patent.

Unfortunately, so far, this sort of information system is not available in China (Lei, 1988 & Academia Sinica, 1991).

The second channel for current progress information is via conferences, where the participants exchange information personally. How do British scientists view conferences as a source of current progress information? **Table 5.1** is from the Royal Society Survey in 1981.

Table 5.1 Conferences as An Information Source

Royal Society survey in 1981, responses: 149 from Oxford (rate: 63%) and 80 from ICI (rate: 52%)

	Oxford overall	Oxford physics	**Oxford chemistry**	ICI overall	**ICI chemistry**
needs more effort to extend this resource	13%	8%	**17%**	23%	**23%**
present effort in organizing them is about right	53%	51%	**52%**	59%	**60%**
too many conferences have been around	34%	41%	**31%**	18%	**17%**

There is a slight difference in view on conferences between industrial scientists and academic scientists in UK. The survey showed that industrial scientists at ICI favoured greater expenditure and effort on conferences than favoured less, although academic scientists at Oxford favoured the status of conferences at that time.

One plausible reason may be that the heavy competition in industrial research prevents both informal communication and current research information systems from covering industrial R&D activities at early stages. Therefore conferences become more important to industrial scientists for the purpose of current awareness.

In Chen's survey on Chinese pharmaceutical scientists information needs and satisfaction in 1989, no respondents regard conference as an effective channel for current awareness, because there are not enough conferences for them. It was reported in 1987, there were 30 regional and national pharmaceutical conferences in China with about 4,000 attendants (China Pharmaceutical Year Book 1987). Given there are 35,000 S&T workers in the field, on average each Chinese scientist could attend such a conference every 7 year; which is much out of the line in comparison with the western figure of 1-2 conference per scientist per year (Meadows, 1974).

Because of the great importance of foreign S&T information to Chinese R&D, international conference is one of the most valuable current information source for Chinese scientists.

However, only very small fraction of Chinese scientists have the chance to attend international conference. In 1987, China held four international pharmaceutical meetings or conferences with 370 foreign attendants and 400 Chinese attendants, accounting for **1%** of the 35,000 Chinese S&T workers in the field. In the same year, thirty Chinese scientists attended six international pharmaceutical meetings or conferences abroad. They account for only **0.1%** of the 35,000 S&T workers in the field (China Pharmaceutical Yearbook 1987).

The third channel for current progress information is via primary and secondary literature.

The rank of information searching activities for current awareness purpose by the two countries' scientists are shown in **Table 5.2 and 5.3**. In Chen's questionnaire, two activities were omitted: using SDI, reading patent specifications. The reasons for doing that are as follows.

Table 5.2 Mean Rank of Activities in Searching Current Information by British Scientists

Royal Society survey in 1981, responses: 149 from Oxford (rate: 63%), and 80 from ICI (rate:52%)

	Oxford overall	Oxford physics	**Oxford chemistry**	ICI overall	**ICI chemistry**
1.scanning journals	1.35	1.35	**1.17**	1.86	**1.76**
2.scanning "Current Contents"	3.24	3.33	**3.28**	3	**4.90**
3.colleagues recommending papers	2.23	2.02	**2.62**	3.72	**4.21**
4.scanning abstract journals	3.01	3.17	**3.16**	3.64	**3.47**
5.reading reviews	3.34	3.18	**2.92**	4.34	**4.24**
6.SDI	4.64	5.08	**4.42**	1.89	**2.26**
7.reading patent specifications	-	-	-	5.91	**5.04**
8.using NEW DRUG BULLETIN*	-	-	-	3.95	**3.19**
9.using PATENTS BULLE-TIN*	-	-	-	4.56	**2.58**
10.using MIDAS*	-	-	-	5.21	**5.41**

* ICI inhouse indexes

Table 5.3 Activities of Searching Current Information by Chinese Scientists

Chen's survey in 1989, responses: 56 from pharmaceutical scientists in Beijing and Shanghai (rate: 56%).

Activities	rank order	no of persons
Scanning journals	1	46
Scanning abstract journals	2	33
reading reviews	3	31
using inhouse bulletin	4	16
scanning "Current Contents"	5	4
colleagues recommending papers	6	0

1. Selective Dissemination of Information (SDI) is still a very rarely used service in China. It was not available in Chinese medical and pharmaceutical fields until 1987 when the China Medlars retrieval centre was set up in Beijing. Currently, the national centre provides just over 500 SDI services whereas there are about 7000 R&D projects in the field in China each year (Wu, 1989 & White Paper, 1991).

2. The Chinese survey does not distinguish scientists by subjects such as chemistry, physics etc.. Because patent information is generally regarded as chemistry related in pharmaceutical sciences, therefore the Chinese survey on patent information would not be comparable with the Royal Society survey which emphasised *chemists*' patent information needs and uses.

From **Table 5.2 and Table 5.3** we could get the following results.

Both British and Chinese scientists mainly rely on the traditional mean of scanning journals - it is the first rank in the UK survey and Chinese survey. The effectiveness of such a searching activity would greatly depend on the journal collection in scientists' institution library and local S&T libraries.

SDI was rated as the second most frequently used activity by chemists at ICI; whereas, Oxford chemists gave it the 6th rank. As one might expect, because of the high cost of SDI in terms of manpower and/or technology, only industrial scientists can afford this service.

The usage of SDI by academic scientists has been improved little since then. In Martyn's survey in 1986, the use of SDI by British academic scientists still remained very low rank- the 11th of the total twelve searching ways (Table 5.8).

British academic and industry scientists rank scanning abstract journal at a similar level - the 4th by the former and the 5th by the latter.

It is clear that academic chemical scientists at Oxford rely on colleagues recommendation and reviews for current information more than industrial scientists at ICI. ICI chemists rely on SDI, inhouse patent bulletins more than academic scientists.

This reflects that there are better information services in pharmaceutical industry than in academic institutions, whereas UK academic scientists are still in favour of traditional ways such as personal contacts, reviews for current awareness which are greatly self supported. The nature of heavy market competition means UK pharmaceutical companies could not afford missing of information and delay in getting information.

Chinese scientists ranked *abstracting journals* at the 2nd, *reviews* at the 3rd, *inhouse bulletin* at the *4th* and *Current Contents* at the 5th. There are no report on *colleagues recommending paper* by Chinese scientists.

UK academic scientists ranked *colleague recommending paper* at 2nd, *reviews* at the 3rd, *abstracting journal* at the 4th and *Current Contents* at 5th.

UK industrial scientists ranked *SDI* at the 2nd, *inhouse bulletins* at the 3rd & 4th, *abstracting journal* at the 5th, *colleagues recommending papers* at 6th and *reviews* at the 7th.

Both Chinese scientists and British academic scientists rank abstracting journal and review as frequently used methods. But British academic scientists show much more use of colleagues recommending papers than Chinese scientists. British academic scientists rank review higher than abstracting journal whereas Chinese give the opposite rank.

Comparing to British industrial scientists, Chinese scientists rank abstracting journal and reviews relatively high in their index. British industrial scientists rank SDI, inhouse bulletins and colleagues recommending papers relatively high in their index.

In China, each big research institute usually has a library and an information department. The latter is responsible for compiling inhouse information bulletins. This is similar to the situation in the UK pharmaceutical industry. So ICI chemists rank inhouse bulletins at the 3rd of total 10 searching activities whereas Chinese scientists also reported certain use of such information service for current awareness.

5.3.2 How do scientists trace accomplished work in a particular area

In tracing what has been accomplished already in a particular area, how do scientists proceed?

Table 5.4 and 5.5 show the retrospective searching activities favoured by British and Chinese scientists respectively.

Table 5.4 Mean Rank of Activities in Retrospective Search by British Scientists

Royal Society survey in 1981, responses: 149 from Oxford (rate: 63%), and 80 from ICI (rate:52%)

	Oxford overall	Oxford physics	**Oxford chemistry**	ICI overall	**ICI chemistry**
following up references cited in relevant papers	1.50	1.39	**1.71**	2.01	**2.46**
online searching	3.52	3.25	**3.67**	2.15	**2.16**
following up references cited in reviews or books	1.94	1.82	**1.88**	2.27	**2.37**
searching through abstracts journals	2.26	2.31	**1.93**	2.63	**2.09**
searching SCI	3.19	3.31	**3.14**	3.32	**3.45**
searching New Drug Bulletin*	-	-	-	3.94	**2.75**
searching MIDAS*	-	-	-	4.56	**4.67**
searching Patents Bulletin*				4.74	**2.78**

* ICI inhouse bulletin

Table 5.5 Activities of Retrospective Search by Chinese Scientists

Chen's survey in 1989, responses: 56 from pharmaceutical scientists in Beijing and Shanghai (rate: 56%).

Activities	Rank Order	No of person
Searching through abstract journals	1	56
following up references cited in relevant papers & reviews	2	37
searching inhouse bulletins	3	19
searching computerized data-bases	4	10
searching SCI	5	1

British academic scientists (Oxford chemists) rank following up references at the 1st, abstracting journal at the 2nd, SCI at the 3rd and online at the 4th.

British industrial scientists (ICI chemists) rank abstracting journal the 1st, online 2nd, following up references the 3rd, inhouse bulletin the 4th, and SCI the 5th.

Chinese scientists rank abstracting journal the 1st, following up references the 2nd, inhouse bulletins the 3rd, computerized databases the 4th and SCI the 5th.

The domination of the traditional methods of following up references cited in relevant papers or reviews is striking in the British academic sector. However, ICI chemical scientists regarded this as less important than searching online or searching through abstract journal. This reflects the combination of high online application in pharmaceutical company and good bibliographical control by CA and databases in chemical field.

Chinese scientists regarded following up references as less important than searching abstracting journal. The main reason may be that Chinese scientists feel less confident in their ability of obtaining or accessing literature comprehensively in their field.

It is clear, in the early 1980s British industrial scientists relied on online searching much more than their academic counterparts. In 1981, online was ranked the second by ICI scientists but the 4th by Oxford scientists.

By 1986, when Martyn conducted the national survey for Aslib, online searching by academic scientists was reported as still in low usage - the 9th searching activity of total 12, comparing to the 3rd rank in the industrial scientists index (Table 5.8).

Computerized information technology (or IT) was introduced into China only in the early 1980s, it has been mainly concentrated in the big cities. Ten of the 56 respondents in Beijing and Shanghai pharmaceutical research institutes have used some kind of computerized information retrieval.

It seems that in house bulletins are regarded as useful for retrospective searching-by ICI scientists and Chinese scientists.

How often do scientists have to trace literature back to decades ago?

Differences in using literature from various periods usually exists between disciplines. This study shows that a difference also exists between the two nations (**Table 5.6 & 5.7**).

Table 5.6 Tracing Back Literature by British Scientists
Royal Society survey in 1981, responses: 149 from Oxford (rate: 63%), and 80 from ICI (rate:52%)

	Oxford overall	Oxford physics	**Oxford chemistry**	ICI overall	**ICI chemistry**
19th century					
never use	64	79	**47**	50	**25**
occasional use	32	21	**49**	45	**65**
regular use	4	0	**4**	5	**10**
1900-1940					
never	28	39	**13**	25	**10**
occasional	64	59	**76**	58	**60**
regular	8	2	**11**	17	**30**
1940-1960					
never	2	3	**0**	6	3
occasional	49	68	**33**	45	**25**
regular	49	29	**67**	49	**72**
1960-1970					
never	0	0	**0**	0	**0**
occasional	5	7	**0**	10	**11**
regular	95	93	**100**	90	**89**
1970-1979					
never	-	-	-	0	-
occasional	-	-	-	1	-
regular	-	-	-	99	-

Table 5.7 Tracing Back Literature By Chinese Scientists

Tianjin survey in 1988, responses: 182 from medical and pharmaceutical scientists

in Tianjin (rate: 61%).

	before 1960	1960s	1970s	1980s
never use	97%	92%	63%	0
use	3%	8%	37%	100%

As we would expect, the older the literature, the less it is consulted. Chemists (at both Oxford and ICI) used the older literature far more than physicists, probably for preparative details of compounds.

The immediacy in using literature by Chinese medical and pharmaceutical scientists is striking. Less than 40% of them use literature of ten years old, comparing to 100% British scientists; less than 10% of them use literature of 20 years old, comparing to more than ninety percent of British scientists; the Chinese figure of using literature of more than 30 years old is very small - only 3% of Chinese scientists in comparison with 60% of British.

The immediacy in using literature usually happens in new subject fields or sciences. It is also more likely to happen in developing countries where most scientific disciplines are very young. The immediacy may also reflect the difficulty for Chinese scientists to obtain older scientific literature or more precisely "older foreign language literature".

5.3.3 How do scientists search for information in general

In theory, scientists' information needs can be divided into three categories- current awareness, retrospective searching and day to day consulting. However, in practice, the above needs and searching may not be distinguished so clearly as black and white. A scientist going to do a retrospective retrieval may also want to satisfy some of his current awareness needs. On the other hand, one seeking current progress information may start retrospective retrieval at any time when he finds any striking traces.

Therefore, sometimes information scientists do not bother to ask the real purpose for a search activity, but directly compare all kinds of searching together.

Table 5.8 & 5.9 & 5.10 generally show searching activities favoured by British and Chinese scientists. The lower rates in Tianjin survey (Table 5.10) than ISTIC (Table

Table 5.8 Information Searching Activities by British Scientists

Martyn's survey in 1986, responses: 266 from nationwide scientists in all subjects (rate: 38%).

	academic		Indus.& gover.		all	
	action	value	**action**	value	**action**	value
follow up references cited in relevant papers	**1**	1	**1**	1	**1**	1
keep up with the literature by reading current papers	**2**	2	**2**	2	**2**	2
search through abstracts journals	**3**	6	**3**	7	**3**	6
do an online search or have one done for you	**9**	8	**3**	6	**8**	7
rely on another member of your team to collect information	**8**	9	**12**	11	**9**	9
collect references from other colleagues	**5**	5	**5**	4	**5**	4
use a personal index or other personal record of S&T data	7	7	7	3	**6**	5
use library indexes or catalogue	**10**	12	**10**	12	**10**	12
ask a librarian do a search for you	**12**	11	**9**	8	**11**	11
use standard textbook or monograph	**3**	10	**5**	10	**4**	10
use SDI	**11**	3	**11**	9	**12**	8
try to get unpublished material or pre-print from other workers	6	3	**8**	5	**6**	3

Table 5.9 Information Searching Activities by Chinese Scientists

ISTIC survey in 1981, responses: 1840 from nationwide scientists in all subjects (rate: 23%).

Rank	Activities	% of total respondents
1	scanning journals	98
2	searching through abstracts journals	93
3	following up references cited in relevant papers	87
4	use library indexes and catalogue	87
5	attending conferences	75
6	use inhouse bulletins	72
7	personal contact	58
8	ask a librarian to search for you	30

Table 5.10 Information Searching Activities by Medical and Pharmaceutical Scientists in Tianjin

Tianjin survey in 1988, responses: 182 from medical and pharmaceutical scientists in Tianjin (rate: 61%).

Rank	Activities	% of total respondents
1	scanning journals	76
2	searching through abstracts journals	75
3	following up references cited in relevant papers	59
4	using library index or catalogue	54
5	asking a librarian searching for you	5
6	personal contact	3

5.9) may reflect the different attitudes between ordinary scientists in Tianjin survey (higher response 61%) and the frequent library users in ISTIC survey (lower response 23%).

For British scientists, it is clear that the most used searching ways are: first, **following up references**; second, **reading current papers** and third **searching abstracting journals.**

For Chinese scientists, the first place of most used searching methods is **scanning journals or reading current papers, searching abstract journal** at the second, while **following up references** in the third place.

The results suggest that **scanning journals** still is the most popular method for information searching in the two countries.

Unlike British scientists, Chinese scientists regarded **following up references** as either less important or a more difficult searching method. The explanation is that they face greater difficulty in getting access to and hold of most of relevant papers in the world.

The results also indicate that Chinese scientists quite firmly believe in **the abstract journal** for timely and comprehensive information searching. They seem to be more happy with the current situation in bibliographic control by secondary publication than with the situation in document supply (document supply in China will be further discussed in the later part of this chapter).

British scientists view **personal contacts** (including collecting references from other colleagues, getting unpublished or pre-printed material from other workers) as valuable channels. They rank them at the 5th and 6th of total 12 activities.

By comparison, Chinese scientists regarded **personal contacts** as the least used method for information searching and gathering. This reflects the generally bad communication condition inside China. As far as communication between Chinese scientists and foreign scientists is concerned, language barrier, geographical barrier etc. constitute the major influential factors.

By 1986, British academic scientists still did not use **online searching** very much, probably for financial constraint reason. Academic scientists ranked it the 9th of total 12 activities; whereas industrial and government scientists use it more frequently in the third place.

Because **online searching** is still in its infancy stage in China, neither the ISTIC survey in 1981 nor Tianjin survey in 1988 include it as a searching method.

For British scientists, **using library index or catalogue** and **asking librarian to search for oneself** are not frequently used; ranked at 10th and 11th of total 12 activities. This may reflect that UK scientists do not regard library catalogue and collection as the major source for information searching. Instead, they search scientific literature mainly through secondary publications, computerized databases and informal communication. They do not have to worry about document supply. They assume most of scientific literature which they have traced would be available either from local library or the national library document supply centre (BLDSC).

Chinese scientists rank **asking librarian to search** at the last. But they seem to be strongly in favour of **using library index or catalogue** ranking at 4th of total 8 activities. About 87% of ISTIC respondents and 54% of Tianjin respondents reported frequently usage. This reflects that Chinese scientists still regard library catalogue as major source for information searching and that Chinese scientists have to greatly rely on local libraries' collection, since there is no national or regional interloan systems available.

A interesting finding in Martyn's survey in 1986 is the least frequently use of SDI by both UK industrial and academic scientists at rank 12th. This is different from the Royal Society result that ICI scientists rank SDI at the second place. This may reflect the difference in IT application between pharmaceutical industry and other industries in UK.

In China there has been a tradition for information officers to compile inhouse information bulletins regularly or occasionally. In ISTIC national survey in 1981, 72% of Chinese scientists reported use of this information source.

5.3.4 Foreign language barriers in S&T information searching

Scientists' ability of reading literature in foreign language

It seems that in general British scientists' ability in French language is similar to Chinese scientists' ability in English language; while the proportion of British mastering German is much higher than the ratio of Chinese mastering Japanese (Table 5.11 - 5.14). Only some old Chinese scientists (the second generation) can read Russian literature. Nowadays, almost all Chinese universities teach English as first foreign language with mostly Japanese or sometime German as secondary foreign language.

Whether all worthwhile work would be published in English ?

In the Royal Society survey (1981), to the question "do you think that a researcher can safely confine himself to the English language literature without risk of missing much important material?", 41% of ICI respondents said "yes", whereas 59% "no". In the survey at Pfizer (Thorp, 1987), to the question "whether all worthwhile work would be published (or re-published) in English?", 69% said "yes", 26% "no" and 5% were unsure. Although the two results differ from each other - the ICI result shows a dominant belief of importance of foreign scientific literature, whereas the Pfizer shows the opposite dominance; they all indicate that a significant proportion of British pharmaceutical scientists admitting the existence of foreign language barrier.

Table 5.11 Ability in Reading Foreign Language Literature
by Pharmaceutical Scientists at Pfizer

Thorp's survey in 1987, responses: 58 pharmaceutical scientists at Pfizer (rate:94%).

	French	German	Russian	Japanese
good	10%	9%	0	0
fair	36%	12%	0	0
laborious	41%	41%	3%	0
Nil	10%	36%	97%	100%

Table 5.12 Ability in Reading Foreign Language Literature
by Pharmaceutical Scientists At ICI
Royal Society survey in 1981, responses: 80 from ICI (rate:52%)

	French	German	Russian	other
ICI overall	76%	52.5%	1.3%	6.3%
ICI chemistry	82.5%	70%	0	5%

Table 5.13 Ability in Reading Foreign Language Literature
by Pharmaceutical Scientists in Beijing and Shanghai
Chen's survey in 1989, responses: 56 from pharmaceutical scientists
in Beijing and Shanghai (rate: 56%).

	English	German	Japanese	Russian	French
can read	100%	11%	22%	9%	9%

Table 5.14 Ability in Reading Foreign Language Literature
by Pharmaceutical Scientists in Tianjin
Tianjin survey in 1988, responses: 182 from medical and pharmaceutical
scientists in Tianjin (rate: 61%).

	English	German	Japanese	Russian	French
can read	88.5%	1.6%	27.5%	3.3%	2.2%

To the question *"Do you often discover references to materials published in foreign language?"*, in the Royal Society survey (1981), 43% of respondents at ICI reported regular discovery, 56% reported occasional discovery.

By comparison, more than **90%** of Chinese scientists reported that they regard foreign language literature very important to their R&D activities. Moreover, 14% of them (those **senior research scientists**) confirmed **relying on foreign literature more than relying on Chinese literature** (ISTIC, 1982).

In the ISTIC national survey in 1981,it was reported that apart from reading Chinese literature, 59% of them mainly rely on English language literature for scientific information, 23% mainly rely on Japanese for information, 14% mainly rely on Russian, 4% mainly rely on German and French.

In 1989 Chen's survey on Chinese pharmaceutical scientists, all 56 respondents reported relying on foreign literature more than on Chinese literature. All the 56 respondents reported mainly using English, 22% mainly using Japanese, 11% mainly using German, 9% French and 9% Russian.

What do you do when you find literature in foreign language?

The actions that respondents from ICI and Pfizer suggested they would take when confronted by a foreign language literature are given below (**Table 5.15 & 5.16 & 5.17**).

If a scientist had a knowledge of the foreign language, he would read it in its original language. Otherwise finding an English abstract is a popular choice for all languages. Identifying or commissioning a translation is not a highly favoured option. Ignoring a foreign literature is always the least choice.

How do Chinese scientists do when facing literature in foreign languages unreadable

In ISTIC 1981 survey, 10% of respondents reported that they would commission translation. The figure in Chen's survey in 1989 was 6%. Comparing to the UK figures in Pfizer (Table 5.16), Chinese scientists regarded **getting translation** as less important than British scientists.

Because in China today more than 90% foreign literature imported is in English (ISTIC, 1986), and 90% of Chinese scientists could read English papers, Chinese scientists tend to mainly rely on English language literature and to ignore literature in other languages.

Table 5.15 Reactions to Foreign Language Literature by Pharmaceutical Scientists at ICI
Royal Society survey in 1981, responses: 80 from ICI (rate:52%)

Mean Rank	Actions
1.66	Reading English abstract if there is one
1.67	try to read it in the original language
2.65	try to find existing translation
2.35	get it translated
4.09	ignore it

Table 5.16 Reactions to Foreign Language Literature
by Pharmaceutical Scientists at Pfizer
Thorp's survey in 1987, responses: 58 pharmaceutical scientists at Pfizer (rate:94%).

Actions	French	German	Russian	Japan
read or translate by oneself	47	26	2	0
get help from colleague	15	31	3	0
find English abstract	25	34	41	43
find existing translation	9	13	21	20
get it translated	8	11	19	22
ignore it	4	6	16	17

Table 5.17 Reasons for Ignoring Foreign Language Literature
by scientists at Pfizer

Thorp's survey in 1987, responses: 58 pharmaceutical scientists at Pfizer (rate:94%).

Reasons	French	German	Russian	Japanese
time to acquire literature	6	6	11	10
time to deal with literature	11	13	23	23
cost of translating literature	6	8	17	18
unsure how to deal with it	6	6	11	11

5.3.5 How do scientists assess S&T information services

Do you have problem in tracing information

In general, British scientists enjoy better library information services than Chinese scientists. Over 95% of them have access to relevant abstracting journals and 78% to online searching at their working places, according to Martyn's survey in 1986. By the end of the 1980s, it is estimated that over 90% of scientists in the UK could use online searching at their working place. Therefore, to the question "*Do you have problem in tracing information?* ", the majority (over 70%) of British scientists' answer is "no".

In Martyn's national survey in 1986, 25.6% of the academic scientists, 21.5% of industrial scientists and 30.4% of the government scientists have discovered some literature which they wish they had seen earlier in their projects. Those are so-called "later-finders".

The reasons for late finding include:

1. Failure to make a systematic approach to literature (11% of later finders);
2. Literature were published in unexpected place (16% of later finders);
3. Literature were not indexed as expected (15%).

Therefore, 42% of later finds are caused by searching difficulties, or in other words, only 11% of total 266 respondents did have problem in tracing information.

Information searching difficulty is a problem in China, partly owing to the inability for many middle and small S&T libraries to hold an adequate collection of relevant foreign abstracting journals, partly due to the lack of user education on how to use existing secondary publications. It was reported by ISTIC survey in 1981, that 64% of Chinese scientists have some kind of searching difficulty.

In another survey on a provincial teaching hospital, 88% of respondent medical and pharmaceutical staff reported searching difficulty (Wuhan Hospital, 1985).

During the Cultural Revolution in 1960s and 1970s, most scientific and technological professionals ceased R&D practice. So when China resumed S&T undertaking in the early 1980s, most of Chinese scientists were not familiar with international secondary journals. It seems that scientists' searching ability through abstracting journal has been greatly improved since then. Fewer scientists in Beijing and Shanghai have problems in searching - only 14% of respondents in Chen's survey in 1989.

How do scientists searching through abstracting journals and online systems?

Table 5.18 shows the general good view of abstracting journals by British scientists.

Table 5.18 Is your field is adequately covered by abstracts journals?

Royal Society survey in 1981, responses:

149 from Oxford (rate: 63%), and 80 from ICI (rate: 52%)

	Oxford overall	Oxford physics	**Oxford chemistry**	ICI overall	**ICI chemistry**
too many	1%	0	**2%**	5%	**0**
adequate	77%	78%	**89%**	80%	**90%**
not enough	4%	0	**2%**	5%	**5%**
no opinion	18%	22%	**7%**	10%	**5%**

Nowadays, although online searching are available in all the UK universities, governmental research institutions and big industrial R&D departments, impact of online on hard copy abstracting journals subscription is still very small (Howorth, 1988). It seems that UK university libraries and other S&T libraries will continue to subscribe to the major and well-used printed sources to allow simultaneously access to hard copy by majority users.

Today Chinese scientists regard **searching through abstracting journals** as the second most important searching method, after the method of **scanning current journal.** This reflects that they are satisfied with this information searching channel generally.

In the Royal Society survey in 1981, 66% of ICI respondents had performed an online search in comparison with only 34% of Oxford scientists.

However, by the end of 1980s, online has become a relatively mature tool and technique of information retrieval, despite differences in usage do exist between academic scientists and industrial scientists.

G. B. Howorth in 1988 conducted a survey of all university libraries in the UK on their online services (TCU Msc thesis, 1988). By 1988, 100% of UK university libraries offer online searching services. Of them, 75% reported that the annual number of searches had risen during last two years, only 11% had fallen.

Another nationwide survey of 58 UK chemical companies' online searching performance has been conducted by S. Byway in 1988 (TCU MSc Thesis, 1988). About 56% of the companies had gone further to train users for end-user online searching. Among the five companies Byway interviewed, company (1) and (2) each has a information department of 7 staff conducting 1,000 online searches per annum; company (3) has 16 information staff and annual online searches of 2,000; company (4) has 30 information staff and annual online searches of 1,500; company (5) has 85 information staff and conducts more than 4,000 online searches annually.

By the end of 1986, 60 online searching terminals connecting with European and North American hosts have been established in 27 big cities of China. The biggest international online searching centre is at ISTIC headquarter in Beijing with an annual volume of online searching of $34,600 in 1986 accounting for 15% of the British Library SRIS online expenditure in 1986/87. In 1988, China conducted some 20,000 international online searches accounting for 0.1% of the world figure (see Chapter 2).

According to Chen's survey of 56 pharmaceutical scientists in Beijing and Shanghai in 1989, 8 of them (16%) had used computerized databases. The eight users were all satisfied with the retrieval technique. However, they all reported the inaccessibility to a considerable proportion of literature which have been hit.

According to an ISTIC random survey of 23 searches done in a week in 1986, of a total of 679 journal papers hit, about 17% are not available in China; of total 225 conference proceedings hit, about 73% are not available in Beijing; of total 298 reports hit, about 45% are not available in Beijing; and finally none of total 18 theses hit are available in Beijing (Zhou, 1987). The above results indicate that although online searching is not widely used in China, it seems not to be the major problem for Chinese scientists. The major problem is the limited literature resource and the low satisfaction rate in document supply in China.

How do scientists trace information from reviews?

Apart from secondary publications and the computerized versions, **reviews** provide another tool for information searching.

There are reasons to believe that for many scientists reviews form an important information source for gathering information. **Table 5.19-5.21** are drawn from the Royal Society survey which confirms the high regard in which British scientists hold reviews. It also shows that reviews are regarded as adequate in both quality and quantity in various different fields.

In China, a significant proportion of reviews are written by information officers rather than by scientific researchers. The reviews are so-called "foreign information analysis and research" reports or reviews.

To the question *"are the reviews by Chinese information officers of adequate quality in general?"* in the ISTIC national survey in 1981, 32% of respondents reported "good" quality, 18% "adequate", and 50% claimed the reviews are "not good enough". There is a contrariety in the assessment. This kind of reviews are normally written by professional translating staff who do not necessarily have a scientific background. Inevitably the contrariety happens - on one hand some Chinese scientists with less systematic searching skill and less ability of some foreign languages often request this kind of reviews; on the other hand, this sort of reviews is lack of adequate value from professional scientists' viewpoint.

How do scientists assess library document supply service

British scientists generally enjoy better document supply service than Chinese. Although funds for academic libraries have been reduced in real term and show signs of continuing to be reduced; although there has been a continuous cut in scholarly acquisitions, interloan and national reference services can be called upon to help out in this event.

In Martyn's national survey in 1986, 98% of respondents claimed availability of library of current journals, 94% with the availability of relevant abstracting journals and document delivery service.

The availability of obtaining documents not held locally is said to be almost certainly understated, given the ubiquity of British Library Document Supply Centre (BLSDC) service. The annual satisfactory rate of interlibrary loan requests in BLSDC has been maintained at the level of 90% for long time. In 1989, the rate is 92.3% (BLDSC Figures 1989/1990).

Table 5.19 Do you regard reviews as especially valuable information?
Royal Society survey in 1981, responses: 149 from Oxford (rate: 63%), and 80 from ICI (rate:52%)

	Oxford overall	Oxford physics	**Oxford chemistry**	ICI overall	**ICI chemistry**
yes	86%	86%	**98%**	88%	**93%**
no	14%	14%	**2%**	12%	**7%**

Table 5.20 Are there enough reviews in your field?
Royal Society survey in 1981, responses: 149 from Oxford (rate: 63%), and 80 from ICI (rate:52%)

	Oxford overall	Oxford physics	**Oxford chemistry**	ICI overall	**ICI chemistry**
too many	5%	4%	**7%**	9%	**5%**
enough	79%	84%	**84%**	79%	**80%**
not enough	16%	12%	**9%**	12%	**15%**

Table 5.21 Are the reviews in your field of adequate quality in general?
Royal Society survey in 1981, responses: 149 from Oxford (rate: 63%), and 80 from ICI (rate:52%)

	Oxford overall	Oxford physics	Oxford chemistry	ICI overall	**ICI chemistry**
good	72%	78%	**89%**	87%	**88%**
adequate	22%	19%	**11%**	9%	**12%**
not good enough	6%	3%	**0**	4%	**0**

In China, however, obtaining a relevant document may be more difficult than tracing it. In ISTIC survey in 1981, 64% of Chinese scientists reported searching difficulty while 69% with obtaining difficulty. According to Chen's survey in 1989, to 56 pharmaceutical scientists in Beijing and Shanghai, 42 of them (75%) claimed obtaining difficulty in comparison with 8 of them having searching difficulty.

In 1990, Academia Sinica conducted a survey on the users satisfaction with the document supply. A sample of just under 3,000 scientists from total 50,000 S&T staff in 124 research institutes of Academia Sinica were asked *"Does the document supply by your institute library and the existing library networks satisfy your information needs?"*.

About 60% of scientists reported that they do not satisfy with the document supply because less than 75% of their information needs can be met. There are difference in the unsatisfactory rate among different regions. About 50% of 720 scientists in *Beijing*, 55% of 300 scientists in *North East China*, 46% of 604 scientists in *East* China (including Shanghai), 63% of 369 scientists in *Middle South China*, 80% of 330 scientists in *South West China* and 65% of 512 scientists in *North West China* reported not satisfying with the situation of document supply.

In Chen's survey on pharmaceutical scientists in Beijing and Shanghai in 1989, a similar proportion (**60%**) of users reported unsatisfactory with document supply: 34 of 56 respondents reported less than 50% of their needs could be satisfied by current document supply services. Only 17 of 56 respondents (30% of them) could get over 50% of document they need and only 9% of them could get over 80% of document they need.

According to an ISTIC random survey of 23 searches done in a week in 1986, of total 679 journal papers hit, about 17% are not available in China; of total 225 conference proceedings hit, about 73% are not available in Beijing; of total 298 reports hit, about 45% are not available in Beijing; and finally none of total 18 theses hit are available in Beijing (Zhou, 1987).

The obtaining difficulty is certainly caused by poor library collection locally and no interlibrary loan services available at all, given the relatively poor transport, postal and telecommunication services in China.

In 1984, the Hubei provincial Academy of Medical Sciences conducted a survey on 500 medical and pharmaceutical scientists in the province, with 356 respondents. The results showed that a significant fraction of Hubei scientists (44%) would only use the institution library collection; 27% would try other institution libraries within the province for unsatisfied information needs; 24% would go further to use library collections in other provincial capitals or the three municipalities; 6.6% of them would try foreign contacts for reprints (Hubei Academy of Medical Sciences, 1986). Under the circumstance of today's "information explosion", no single S&T library (even those libraries in developed countries) could claim to be comprehensive in collection. The general limited information resource in Chinese S&T libraries and information centres are eminent (see Chapter 8). However, most of Chinese scientists have been restricted to very limited information collection and resource in their area. Share of the national information resource is still far from reality in China.

Hubei is about three quarter of the size of Britain. It is the 9th most populated province in the total 26 provinces of China; having a similar rank in its industrial, agriculture, as well as scientific and educational productivity. The above results therefore could reflect the backwardness in document supply and interloan system in China.

There is little doubt that in China today the most serious crisis is the inadequate resources of primary literature, especially in foreign information. The combination of rapid inflation at home and in the world scientific literature market has made the situation intolerable.

When a professor in the Shanghai Biochemical Research Institute of Academia Sinica was interviewed by the author in 1989, he gave the following assessment.

"Because of the financial problem, many S&T libraries and information institutes cancel their already limited journals subscription and books acquisition.

"The situation is becoming worse for the current 3-5 years, when even some biggest S&T libraries or information institutes greatly cut their acquisitions, for example the Shanghai S&T information institute, the Shanghai library of Academia Sinica, and Guangzhou S&T library.

"To improve other information services, such as online searching, SDI, foreign literature translation etc. is definitely needed. However, without sufficient resources of primary literature and secondary publications, those services will inevitably become unwarranted decoration to the poor information system.

"Without a stable and rich S&T literature resource, one cannot think of any Chinese R&D work being able to be up to the world standard".

His assessment has been currently supported by the investigation conducted in S&T information system in Academia Sinica. "Due to the rapid inflation in domestic and foreign S&T literature for the last ten years, a substantial cancellation of every kind of literature has happened in almost all S&T libraries. In the Library of Academia Sinica in Beijing alone, from 1985 to 1989, the number of foreign journals have been reduced by 50%." (Academia Sinica, 1991). Even the national S&T libraries have received substantial cut in their foreign journal subscription.

Since the early 1980s, many UK academic libraries have been under a finance constraint and reduced their subscription of learned journals and books. However the above cut in subscription is made under the assumption that British Library Document Supply Centre would function as a back up service to the academic libraries (Line, 1990). So the current constraints in UK academic libraries, although considerable, is nothing like the serious situation in Chinese S&T libraries and information centres.

5.4 Concluding Notes

5.4.1 Value of Foreign Language Information

Although a significant proportion of British pharmaceutical scientists admits the existence of foreign language barrier, up to 70% of them think all worthwhile work would be published in English.

By comparison, more than **90%** of Chinese scientists reported that they regard foreign language literature very important to their R&D activities. Moreover, 14% of them (those senior research scientists) confirmed **relying on foreign literature more than relying on Chinese literature**.

5.4.2 Scientists' Information Accessing Ability

In general it is perceived that **scientists in UK have higher information accessing ability than scientists in China.** British scientists generally enjoy better document supply service than Chinese. Although funds for academic libraries have been reduced in real terms and show signs of continuing to be reduced; interloan and national reference services can be called upon to help out in this event.

About 60% of Chinese scientists do not satisfy with the situation of document supply by their institute library or existing library networks, because less than 75% of their information needs can not be met. The unsatisfactory is reported by 50% of scientists in Beijing and Shanghai and by 80% of scientists in remote areas.

Under the circumstance of today's "information explosion", no single S&T library could claim to be comprehensive in collection. However, most of Chinese scientists have been restricted to very limited information collection and resource in their area, because of the poor communication and transport condition. Share of national information resource is still far from reality in China, without national or regional interloan system or document supply system available.

5.4.3 Scientists' Information Searching Ability

1 Generally, because the several large **world secondary publications** provide comprehensive coverage over chemistry and life science literature in the world, **both British and Chinese scientists have little problems in literature searching**. In China the national secondary publication system now produces 250,000 bibliographic records per year covering about 50% of Chinese literature (see Chapter 8). Generally Chinese scientists are also satisfied with the situation in searching domestic literature.

However, there are differences in scientists' information searching ability between the two countries. The common features and differences are summarized as follows:

2 Both British and Chinese scientists mainly rely on the traditional mean of **scanning journals** for current awareness - it is the first rank in the UK survey and the Chinese survey. The effectiveness of such a searching activity would greatly depend on the journal collection in scientists' institution library and local S&T libraries.

3 SDI service for current awareness is the second most used searching method by ICI chemical scientists. However, it is much less used by British academic chemical scientists and by Chinese scientists.

4 That ICI chemists rely on SDI, inhouse patent bulletins more than academic chemical scientists reflects that there are **better information services** in pharmaceutical industry than in academic libraries, whereas UK academic scientists are still in favour of traditional ways such as personal contacts, reviews for current awareness which are greatly self supported.

5 Both Chinese scientists and British academic scientists rank abstracting journal and review as frequently used methods. But British academic scientists show much more use of colleagues recommending papers than Chinese scientists. British rank review higher than abstracting journal whereas Chinese give the opposite rank.

6 Comparing to British industrial scientists, Chinese scientists rank abstracting journal and reviews relatively high in their index. British industrial scientists rank SDI, inhouse bulletins and colleagues recommending papers relatively high in their index.

7 In China, each big research institute usually has a library and an information department. The latter is responsible for compiling inhouse information bulletins. This is similar to the situation in the UK pharmaceutical industry. ICI chemists rank **inhouse bulletins** at the 3rd of total 10 searching activities whereas Chinese scientists also reported certain use of such information service for current awareness.

8 Unlike British scientists, Chinese scientists regarded **following up references** as either less important or more difficult searching method. The explanation is that they face greater difficulty in accessing to relevant papers in the world.

9 Chinese scientists quite firmly believe in **abstract journal** for timely and comprehensive information searching. They seem to be more confident in their ability in information searching than in obtaining literature (i.e. accessing to information).

10 UK scientists do not regard **library catalogue and collection** as the major source for information searching. Instead, they search scientific literature mainly through secondary publications, computerized databases and informal communication. They do not have to worry about document supply. They assume most of scientific literature which they have traced would be available either by local library or the national library document supply centre (BLDSC).

By comparison, Chinese scientists still regard library catalogue as major source for information searching. And Chinese scientists have to greatly rely on local libraries' collection, since there is no national or regional interloan systems available.

5.4.4 Informal Scientific Communication

Personal contact (colleague recommending papers, exchange preprint and reprint etc.) is not a frequently used channel in China as in the UK. The poor communication and transport condition in China and the weak link between Chinese scientists and the world scientific community may be the major causes. The informal communication between Chinese scientists and foreign scientists is at a low level today- most of Chinese scientists are going abroad to study whereas most of foreign scientists are coming to China for lecturing.

Conference is one of informal channels for scientists to get aware of current research work. In general British scientists are satisfied with the status of conference as a communication channel. On average each British scientist attends 1-2 conferences per year.

There are not enough conferences for Chinese scientists. Conference is not a frequently used information channel for current awareness in China. On average each Chinese S&T worker attends conference every 7 year. The great importance of foreign S&T information to Chinese R&D have made *international conference* one of the most valuable information source for Chinese scientists. However each year, only 1% of Chinese pharmaceutical scientists could attend international conferences in China and only 0.1% of Chinese pharmaceutical scientists have chance to attend international conferences abroad.

5.4.5 Enhanced Searching Ability by Online

It is clear, in the early 1980s British industrial scientists relied on online searching much more than their academic counterparts. In 1981, online was ranked the second by ICI scientists but the fifth by Oxford scientists. During the period of the 1980s, online services have been widely spread in the whole research community in the UK.

By 1988, 100% of UK university libraries offer online searching services. Of them, 75% reported annual number of searches has risen during last two years. However, British academic scientists still use online less frequently (9th rank) than industrial scientists (3rd rank).

By the end of the 1980s, IT application has been further improved in UK industrial R&D sector. About 56% of UK chemical companies have started end user searching in 1988. In 1988, the online volume in a middle sized pharmaceutical company Pfizer UK is ten times the average figure in a UK academic or public library.

Computerized information technology (or IT) was introduced into China in the early 1980s, it has been mainly concentrated in the big cities.

By the end of 1986, 60 online searching terminals connecting with European and North American hosts have been established in 27 big cities of China. The biggest international online searching centre is at ISTIC headquarters in Beijing with an annual volume of online searching of $34,600 in 1986 accounting for 15% of the British Library SRIS online expenditure in 1986/87. In 1988, China conducted some 20,000 international online searches accounting for 0.1% of the world figure and being only 4 times the online volume in a large UK pharmaceutical company Glaxo. The average online volume in the 60 Chinese online searching centres is 2-300 searches per year, which is similar to that in a medium sized British academic library. The current status of online searching in China is similar to that in Europe in the early 1970s.

Generally, Chinese scientists are satisfied with online searching results but not with the document supply service later on. About 17% of journal papers, 73% of conference papers, 45% of reports and 100% of theses hit are not available in China.

Chapter 6 Scientists' Information Using Disseminating Ability

In Chapter 5, British and Chinese scientists' information needs, searching and acquiring, or in short their "**information accessing searching ability**" have been compared and studied. In this chapter, let us look at their information activities on the production side of scientific communication. The aims in this chapter are to analyse and "measure" the two nations' scientists "**information using and disseminating ability**". Such a measurement will provide some data and evidences for planning the reform of Chinese S&T information flow system in Chapter 9.

6.1 Scientific Literature Production and Scientist's Information Ability

In the practice of science, there are four important characteristics which mostly concern us here.

First, a scientist **must read** the papers and books by other workers, except the man who is the sole practitioner in the field and therefore can read nothing beside his own papers. He has to practice scientific research on the base of previous work in the field. As Newton said " If I have seen further, it is by standing on the shoulders of giants".

Secondly, a scientist **must cite** other workers' papers in his publications if his work is related to or based on them. In the practice of scientific research a scientist must draw on others' experiences and findings because science is regarded as a process of continuous renewal and cumulation. As a result, in scientific literature, papers beget papers: a scientist will read and assimilate the work of his precursors and peers and use their experience as a catalyst and stimulant to his own activity. Their papers will act as a platform and a springbank for his published work and they will be cited in his paper. His own published works will be sequentially cited by his peers and heirs and so the fabric of the literature will be worked.

Thirdly, a scientist **must publish** or perish in his subject field, except for those whose work are not allowed to published by the employer for confidential reasons. There are always competition and urge to publish within a scientific community, though this publish or perish does not apply to scientists in industry.

Fourthly, a scientist **must get his work approved** by the refereeing system of scientific journals. New contributions for publication are customarily examined for acceptability by the refereeing system which acts as a filter to remove unworthy contributions.

After all, while a scientist writes papers to contribute to scientific knowledge, he is involved in an information processing procedure including using, generating and disseminating activities.

In this chapter, scientists' information disseminating ability in the two countries is to be compared (§6.2 and §6.3).

A scientist's or a group of scientists' information using ability is a subjective term and is difficult to define.

To a looser extent, we may define it as "when a scientist (or a group of scientists) is exposed to an information environment, his ability (or the group's ability) to integrate others' knowledge and experience into his (or its) own work".

Obviously it depends on the scientist's or the group of scientists' intelligence, foreign language ability and scientific training. It is further conditioned by their information environment, their information accessing ability, the academic level of their research work and many other influences. Since this study is only interested in the comparison of the two nations' scientists, we may assume that the intelligence, foreign language ability and scientific training as *ceteris paribus*. Therefore major influences on the two nation scientists' information using ability would be their information accessing ability and the academic level of their research work.

A convenient indicator system for "information using ability" is **citing behaviour** in scientific literature production. In §6.4 and §6.5 we are to study the two nation scientists' citing behaviour.

To study scientific literature production, there are some quantitative methods in the information science namely **bibliometric studies**. Among the bibliometric studies, Bradford's law is about the concentration and dispersion of papers in journals; Lotka's law is about the concentration of scholarly productivity; the aging of literature is about the utility of literature over time; the citation analysis studies the relationship between citing papers/authors/journals and cited papers/authors/journals. In this chapter, the bibliometric methods are to be applied to compare the scientific literature production by the two countries' scientists.

6.2 Scientists' Ability in Disseminating R&D Information

6.2.1 Journals' Publishing Capacity

Within science, the primary journal fulfils four functions: quality control, assignment of priority to authors, dissemination of information and permanent archive. Although China has a short history of scientific journal publication less than seventy years, the Chinese system is quite similar to the systems in scientific advanced western countries. In each subject journals receive papers from authors and send them to other scientists who act as referees. With the referees' reports to help him, the editor decides whether or not to publish. Often a paper is returned to the author for revision in the light of the referee's report. Finally, if a paper is accepted, it is sent to the printers and eventually appears in print, usually **6-12** months after the initial submission to the British journals (Royal Society, 1981) or **12-18** months after the initial submission to the Chinese journals (Wu, 1988).

That the average editing time for submitted journal paper in China is 1.5-2 times the length in UK may in a sense reflect a relatively smaller dissemination capacity by Chinese journal than British journal.

In 1979, there were about 1500 scientific learned journals in UK, excluding social science, engineering and clinical medicine (Royal Society, 1981). Another estimate is that there are some 4,000 S&T learned journals being currently published in UK (Vickery, 1987). By comparison, in 1988, China published around 3000 scientific and technical journals (Zhong, 1990).

There are some 220,000 scientific and technological workers in UK (Annual Review of Government funded R&D, 1990) comparing to 7.8 million in China (White Paper, 1987). If the factor that China has a S&T manpower which is 35 times the UK whereas China has a number of S&T journals similar to UK is taken into account; then the number of journal per S&T worker in China is far too lower than in UK. In other words, **China has a much smaller journal publishing capacity for disseminating its R&D results than the UK.**

Moreover, Chinese journal has a smaller productivity than the world journal in terms of average publications per journal per year. By the late 1980s, the average publication rate of Chinese journals was reported as **100** papers per journal per year (Yan, 1988, Zhang, 1988 and Li, 1988). The Chinese rate in *the late 1980s* is more or less equal to the average rate *in the late 1960s'* USA which was reported as **110** papers per journal per year (Wooster, 1979).

Since the 1960s, the size of world scientific journal in terms of the number of papers or the number of pages has been growing slightly and steadily (Royal Society, 1981). A random survey on 35 British scientific journals in SCI (1988), by choosing the journals with "British" in the beginning of their titles, showed that the average publication rate was **171** papers per journal per year *in 1988*.

Perhaps, Chinese scientific journal is the one of the most competitive publication system in the world. It is reported that there are somewhat **five hundred** medical and pharmaceutical learned journals against **4.5 million** S&T professionals in the field in China (Wu, 1988). That is one journal for every 10,000 potential scientific authors on average.

The lack of journals for disseminating R&D results in China has forced many junior research workers out of scientific publication (Wu,1988). If we adopt the Chinese scientific job hierarchy and **assume the senior research scientists as potential authors** conservatively, there are about **seven thousands** of such potential authors in Chinese pharmaceutical areas (seeing Chapter 3). It is estimated that there are 60-80 learned journals in Chinese pharmaceutical areas (China Pharmaceutical Yearbook 1987 & China Pharmaceutical Abstracts, 1989). Under that circumstance, there will be 100 potential authors for each journal in the field. Given that each Chinese journal publishes 100 paper each year, then one can roughly deduce that the average publication rate of Chinese pharmaceutical scientists is **one** paper per person per year.

One old survey on the number of publications produced by staff members of the UK university chemistry departments in 1969 reported an average productivity of *2.36 papers per staff annually* (Baglow, 1979). School of Pharmacy in University of London reported an average productivity of 3 papers per staff among its 61 academic staff in 1987-88 (School of Pharmacy Annual Report 1987-88).

Though there is no similar survey conducted in China, according to the above estimate of *one paper per research scientist annually* in Chinese pharmaceutical areas, we could estimate that a Chinese scientist annual publication capacity is only about 1/2 or 1/3 that of a British scientist. This may have been resulted from the lower S&T journal capacity in disseminating the nation's R&D results in China in comparison with the situation in the UK.

It has been recently highlighted that there is difficulty in journal publication for ordinary Chinese scientists. "*There are several problems facing today's scientific journal publishing industry in China. Firstly, there are not enough journals for scientists to publish their work which results in the very high rejection rate in all grades of journals. Secondly, there are not enough editors for each journal- the average number of editors for each journal is 2; which is lower than the government guide-line: 3 for Quarterly journal, 5 for bimonthly journal, and 8 for monthly journal. The lack of resource for journal publishing has inevitably* prevented the growth in the size of journal and *the improvement in publishing speed. Thirdly, there is longer delay for journal paper publishing which is 50% or 100% longer than the world speed, in terms of the time requested for refereeing, editorial and printing work". (Wu,* 1988)

By comparison, Royal Society's survey in 1981 showed that only 1% of British scientists thought the journals in their fields were not enough. About 25% of British scientists even thought there were too many journals while the majority 72% thought there were about enough journals (Royal Society, 1981).

6.2.2 Scientists' Information Disseminating Ability

So far, China has reached a scientific literature production of **200,000-400,000** papers per year. One estimate is from the items being indexed in Chinese secondary publications (abstract or index journals) which total **200,000** entries each year, including journal papers and other documents (White Paper, 1987). Another estimate is from the latest S&T survey by the State S&T Commission (White Paper, 1990). In 1988, there were 52,000 S&T journal papers and 470 million words of S&T monographs published by government scientists, and 112,000 S&T journal papers and 1500 million words of monographs by university researchers. Given that 8000 words[10] of monographs equal to one journal paper, the total number of S&T papers published by Chinese scientists were **400,000** in 1988.

10 The average number of words in each journal paper is 8000, according to the survey on CJCP (1985-1987).

In the world, despite Chinese scientific literature has grown relatively quickly since the late 1970s, from 0.7% of total CA items in 1980 to 3.5% in 1988 which made a total of 13,639 Chinese records in that year (Jhaveri, 1989), China is still a very small scientific nation contributing to the world science. **Table 6.2.1** shows the contribution made by China to world pharmaceutical literature is still at a small scale comparing with the UK.

Table 6.2.1 Contributions by China and UK to Pharmaceutical Literature as percentage of total papers in CA

Source from Sec.1 Pharmocology, Sec.4 Toxicology, Sec. 63 Pharmaceuticals and Sec.64 Pharmaceutical analysis in CA *

	1972		1988	
	UK	China	UK	China
SEC1	6.5	1.4	7.1	1.4
SEC4	4.6	0.6	6.1	0.8
SEC63	4.1	1.3	5.5	1.8
SEC64	3.6	1.9	2.4	0.4

* the result is from an online search conducted in STN CA FILE(1967,1-1990,10) in Oct., 1990.

There is a contradictory situation in Chinese scientific literature production. On one hand, China produces a great number of scientific papers each year- somewhat 200,000 - 400,000. On the other hand, only a very small proportion (no more than 10%) of the Chinese scientific literature could disseminate to the world by means of international secondary publication services.

There is a hierarchy of different grades of papers and authors:

At the top of the hierarchy is the group of papers being published in foreign or international journals in English (or sometimes in other foreign languages) by Chinese scientists. The total number of this group of papers was about **16,486** in all subjects in 1988 (including government scientists and university researchers) (White Paper, 1990).

At the second level, there are papers published in the high quality Chinese journals and sequentially being indexed in the big international abstracting journals such as CA, BA, SA, IM etc. It was reported, in 1988 total of 13,091 papers with the first authors' addresses in China have been covered by CA accounting for 3.7% of journal papers in CA (Jhaveri, 1989). These 13,000 papers account for at least one third of the total Chinese papers abstracted by international secondary publication services, according to the following estimation.

It was reported that in 1988, SCI covered 10 Chinese journals accounting for 0.3% of total journals in it. EI covered 40 Chinese journals accounting for 1.2% of total journals in it. CA covered 281 Chinese journals accounting for 2% of total journals in it. In USSR, "S&T Abstracts" covered 131 Chinese journals accounting for 0.6% of its journal coverage. In Japan, "S&T Abstracts" covered 40 Chinese journals accounting for 0.3% of its journal coverage. In UK, Science Abstracts covered 62 Chinese journals accounting for 2.2% of its journal coverage. Among the above six world leading secondary publications, Chinese journal coverage in CA accounts for 50% of the total. On this base, one may estimate the number of Chinese papers covered by CA accounts for at least one third of total Chinese papers covered by world secondary publications.

In other words, about **39,000** Chinese papers or 10% of total 400,000 Chinese scientific literature are covered by international secondary publications.

In Chapter 3, the ratio of Chinese pharmaceutical literature being abstracted in CA and in China Pharmaceutical Abstracts was estimated as **1 to** 7 (Table 3.13).

This also supports the finding that around 10% of Chinese papers are indexed by international secondary publications.

At the third level, there are **200,000** Chinese scientific papers (half journal papers and half other documents) annually being indexed and abstracted by 219 Chinese abstracting journals. The 200,000 papers are reported accounting for 50% of total Chinese scientific literature (Huang, 1986).

The other half scientific literature which is not indexed by any secondary publications make up the fourth level of the hierarchy.

The Chinese scientific literature has been crystallized into a "triangle" structure as shown in **Figure 6.2.1**.

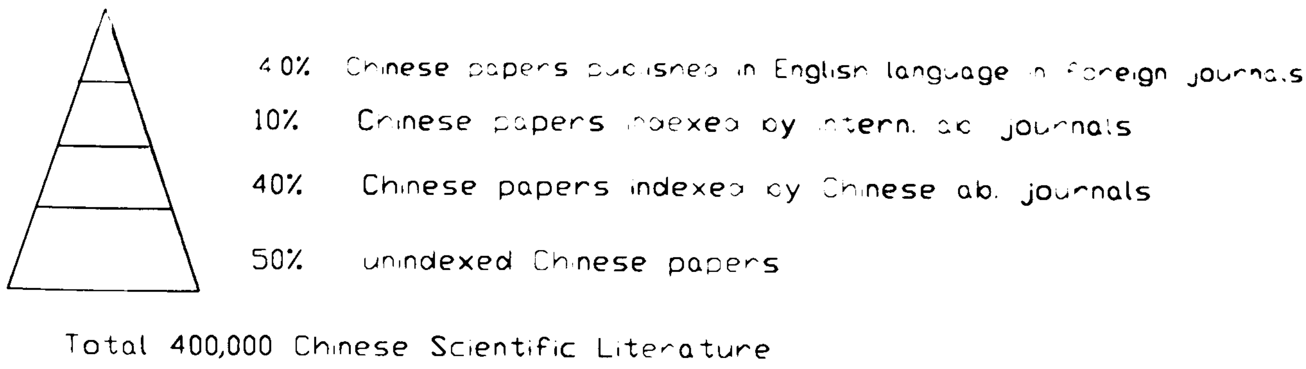


Figure 6.2.1 *Triangle* Structure of Chinese Scientific Literature

Because British scientists use the English language which has been the world scientific language for more than half a century, it is safe to say that all journal papers by British scientists are disseminated on the world communication circuit. Here it must note that 4% of Chinese papers in world journals and 10% of Chinese papers in world secondary publications do not indicate that only such proportion of Chinese literature are at the same academic level as all British journal papers. It only indicates that **Chinese scientists have a much smaller capacity in disseminating information** to the world **than British scientists.**

6.3 The Concentration of Scholarly Productivity

There is a well known effect in scientific communication that is the concentration and dispersion of scholarly productivity.

Lotka's Law provides a measure on the concentration of scientific productivity. It counts the number of items under each author's name in the cumulative index of a journal. The number of authors making N contributions is about $1/N^2$ of those making one; and the proportion of all contributors that make a single contribution is about 60% (Potter, 1981).

The following case is chosen from the cumulative index of a Chinese leading journal "Chinese Journal of Pharmaceutical Science" (YAO XU XU BAO, 1953-1985)" (Pharmaceutical Sciences Journal). (**Table 6.3.1**) "Chinese Journal of Pharmaceutical Science" is the most reputable learned journal in Chinese pharmaceutical field.

Table 6.3.1 Authors' Contribution in Chinese Journal of Pharmaceutical Science (1953-1985)

actual data		Lotka's prediction	
papers per author	authors	paper per author	authors
1-9	2954	1 2-9	1811 976
10-29	58	10-29	129
30 33	2 3	30-35	10.5
36 40	1 1	36-40	6.3
Total	3019	...	...

It seems that the above Chinese data do not confirm Lotka's law very well. Especially **the number of productive authors (those produce more than 10 papers) is only half** of the Lotka's prediction. Perhaps we should not be too surprised at this. Coile (1977) has shown in an extensive study of author productivity that few data sets do conform to Lotka's Law.

According to Coile's hypothesis, there are three possible causes for the deviation in Chinese Journal of Pharmaceutical Science.

Firstly, the community of authors may not be broad enough. Secondly, although the total time span is more than ten years (1953-1985), there is a long period of disturbance (The Cultural Revolution) in the journal publication during 1964-1977. Thirdly, it is possible that the productivity of Chinese eminent scientists is lower than that being predicted by Lotka.

Nevertheless, Table 6.3.1 shows that there is a concentration and dispersion of scholarly production in Chinese pharmaceutical science. Among the overall three thousands of scientific authors in the journal, only 65 person (or 2% of the total) have published more than ten papers for the thirty years (1953-1985). Therefore one could say the eminence of Chinese scientists is 2%.

To study the eminence in the young generation of Chinese scientists, we use a sample of 23 eminent scientists in Academia Sinica. Data is drawn from a biography book edited by Academia Sinica (1987).

In 1986, the average age of the 23 scientists was 44 and they mainly graduated from university just before the start of the Cultural Revolution in 1965. Soon after the Cultural Revolution in the early 1980s, all the 23 had been sent to study abroad for some time ranging from several months to several years.

All 23 scientists give the number of their publications for a self-defined *publishing peak period* during 1977-1986.

Since the sample group of scientists graduated soon after the start of the Cultural Revolution and were without work because of the nationwide cease in scientific practice during that period; we could safely say that the *publishing peak period* represent the first peak in their career. **Table 6.3.2** shows the pattern of the 23 Chinese eminent scientists productivity.

The average time span of **self-defined peak** is **4** years for the period of 1977-1986.

All the scientists have their **peak publishing period** starting from their work abroad. The plausible reasons for that are as follows:

1. Good work conditions abroad, including library information services and laboratory facilities;
2. Good collaboration with other countries' scientists and sometimes with eminent scientists in the world;

3. Good access to word processing facilities and journal publication system;

4. Improved personal foreign language ability and research skill.

During their self-defined peak period, the average publication rate is **4** papers per person per year (including publication inside and outside China).

Table 6.3.2 Eminent Chinese Scientists Productivity during their first peak period after the Cultural Revolution

author case no.	subject	first peak years	total papers	total non-Chinese papers	papers per year	non-Chinese papers per year
1	computer	6	60	17	10	3
2	toxicology	5	38		8	
3	mathematic	6	20	20	4	4
4	physics	2	7	7	4	4
5	physics	1	3	3	3	3
6	chemistry	7	12	6	2	1
7	physics	2	8	8	4	4
8	biology	1	4	4	4	4
9	physics	1	6	6	6	6
10	chemistry	2	2	2	1	1
11	physics	4	7	7	2	2
12	computer	6	30		5	
13	mathmatic	2	5	5	3	3
14	computer	8	20		3	
15	physics	4	20	20	5	5
16	mathmatics	9	40		4	
17	chemistry	2.5	8	8	4	4
18	physics	8	40		5	
19	computer	3	10	10	3	3
20	physics	2	3	3	1.5	1.5
21	computer	4	20	20	5	5
22	biology	2	8	8	4	4
23	chemistry	2	2	2	1	1
Average		4			4	3

All of the 23 scientists had published papers in foreign or international journals in non-Chinese languages. During their self-defined peak period, the average publication rate is **3** non-Chinese papers per person per year.

After returning back to China, 12 of the 23 scientists had been continuing to publish in foreign journals and Chinese journals at a similar speed as when they were abroad.

Today the major differences between the ordinary and eminent Chinese scientists include

1. An eminent scientist publish 4 papers per year while an ordinary senior scientist publish one paper per year.

2. An eminent scientist is able to publish in foreign journals with a speed of 3 papers per year while an ordinary senior scientist mainly publish in Chinese journals.

If we want to know how many eminent scientists there are in China today, we could estimate from the figure of Chinese Academy of Sciences. Those 23 eminent scientists were drawn from 4,000 scientists had been studied abroad and returned back to Chinese Academy of Science in the first half of 1980s. The eminence is therefore estimated as 0.6% of the 4,000 Academia Sinica scientists trained abroad or **0.23% of the 10,000** senior research scientists in Academia Sinica.

By 1990, in the whole China, there were 40,000 Chinese scientists had completed their study/work abroad and returned back, if the above 0.6% of eminence still hold, there would be **200-300** prominent scientists in China.

One may disagree with the above standard of "eminence" which requires the eminent Chinese scientist publishing 3-4 non-Chinese papers in world journals in one year. Nevertheless, it seems to be acceptable in practice. For example, ISTIC also adopted this standard in its study on Chinese authors' productivity. In 1989, there were about **six thousand** Chinese S&T authors (both first and co-authors) being indexed in SCI, of whom the **top 50** authors had more than 4 papers published in world core journals (78% in foreign journals and 22% in Chinese published English journals) (Zhang, 1990).

Given SCI covering less than one tenth of world S&T journals, one could roughly estimate that the number of so-called "eminent" Chinese scientists may be ten times the 50 authors. Therefore there are around **five hundred** eminent scientists in today's China.

Generally, there is a hierarchy of S&T authors corresponding to the triangle structure of S&T literature production (Figure 6.2.1). Overall, there are about 400,000 scientific authors in China.

The most prestigious of the UK learned societies is the Royal Society with 1000 fellows currently. Those scientists elected Fellows of the Royal Society (FRS) are regarded as the most eminent scientists in the UK. They account for **0.4% of total 220,000 S&T workers in the UK**.

The eminence in **China** is several hundred scientists accounting for **0.1%** of 400,000 scientific authors or **0.005%** of total 7.8 million S&T workers; comparing to the eminence of one thousand scientists accounting for **0.4%** of total 220,000 S&T workers in the **UK.**

To compare the productivity of Chinese and foreign eminent scientists is very difficult, because there are few studies on Chinese scientists life productivity. Nevertheless, the following figures may shed some light on the comparison.

Dennis (1954) had looked at the productivity of members of the US National Academy of Sciences and found that his sample had a life time publication range of 27 to **768** papers with a median volume of **145**. In Britain, those chemists elected Fellows of the Royal Society are regarded as the country's most eminent chemists, so Baglow and Bottle (1979) studied their life time productivity. The study showed an average life time productivity of **144** publication for FRS chemists. The study also showed that the first publication age appeared in 24 and the average life time is 72 for the FRS chemists. Therefore, the average publishing time is 72-24=48 years for the FRS chemists. Dividing 144 papers by 48 years, the average productivity for FRS chemists is **3** papers per person per year. From the same study one could also deduce the average productivity for FRS medical scientists is **2.7**.

From the 23 eminent Chinese scientists in Academia Sinica, and the 50 eminent Chinese scientists in the SCI 1989 survey; one could see that the average productivity of Eminent Chinese scientists is **3-4** papers in world journals per person per year.

The productivity of eminent scientists in UK and China seems to compare well.

6.4 Scientists' Citing Behaviours

A citation is the acknowledgement that one document receives from another. In general, a citation implies a relationship between a part or the whole of the cited documents/authors/journals and a part or the whole of the citing documents/authors/journals. Citation analysis is that area of bibliometrics which deals with the study of these relationships.

6.4.1 Citation Analysis & Bradford Distribution in Pharmaceutical Area

Bradford's law is characterized by both concentration and dispersion of specific items of information over different sources of information, which constitute an important feature of scientific literature production. To put it another way, for a search on some specific topic, a large number of the relevant articles will be concentrated in a small number of journal titles. The remaining articles will be dispersed over a large number of journal titles. For such an effect there are three obvious causes:

1. Subject width of journal - those journals with more narrow subject coverage and those specialist journals are more likely to become "core" in the field;

2. Standard and quality of journal - those higher standard journals in a subject are more likely to become "core" in the field;

3. Journal capacity in terms of the number of papers per year - those journals with larger number of papers published per year are more likely to become "core" in the field.

The most profound impact on the theoretical foundation of Bradford's law has come from the efforts of B.C. Brookes. He described the law in two parts:

$$R(n) = a \times n^{b} \qquad (1 \leq n \leq c)$$

$$R(n) = N \times \log\left(\frac{n}{s}\right) \qquad (c \leq n \leq N)$$

These two equations refer to the rising curve and the linear curve of the whole graph which is named "bibliograph" by Brookes (**Figure 6.4.1**).

n is the rank order of periodicals arranged in decreasing order of the number of articles they contribute to a specified subject;

R(n) is the cumulative sum of articles contributed by all periodicals of rank 1 to n ;

a is the number of articles contributed by the most productive periodical (i.e. the periodical of rank 1);

b is the constant if the publications considered cover only a short time-span. Its value is always less than 1;

N is the total number of periodical title that would be expected to publish paper on the subject;

c is the value of n at the point C where the curve runs smoothly into the straight line. Periodicals ranked 1 - C constitute the "nucleus" of periodicals publishing papers on the given subject;

s is the value of n at the intersection of the straight line with the log(n) axis.

For strict conformity with Bradford's law, certain conditions have to be imposed on the bibliography. They are: *(1) the subject of the bibliography must be well defined; (2) the bibliography must be complete, that is, all relevant papers and periodicals must be listed; (3) the bibliography must be of limited time-span so that all contributing periodicals have the same opportunity of contributing papers.*
However, it is found that the form of the graph is surprisingly stable even when these conditions are not fully satisfied (Brookes, 1969).

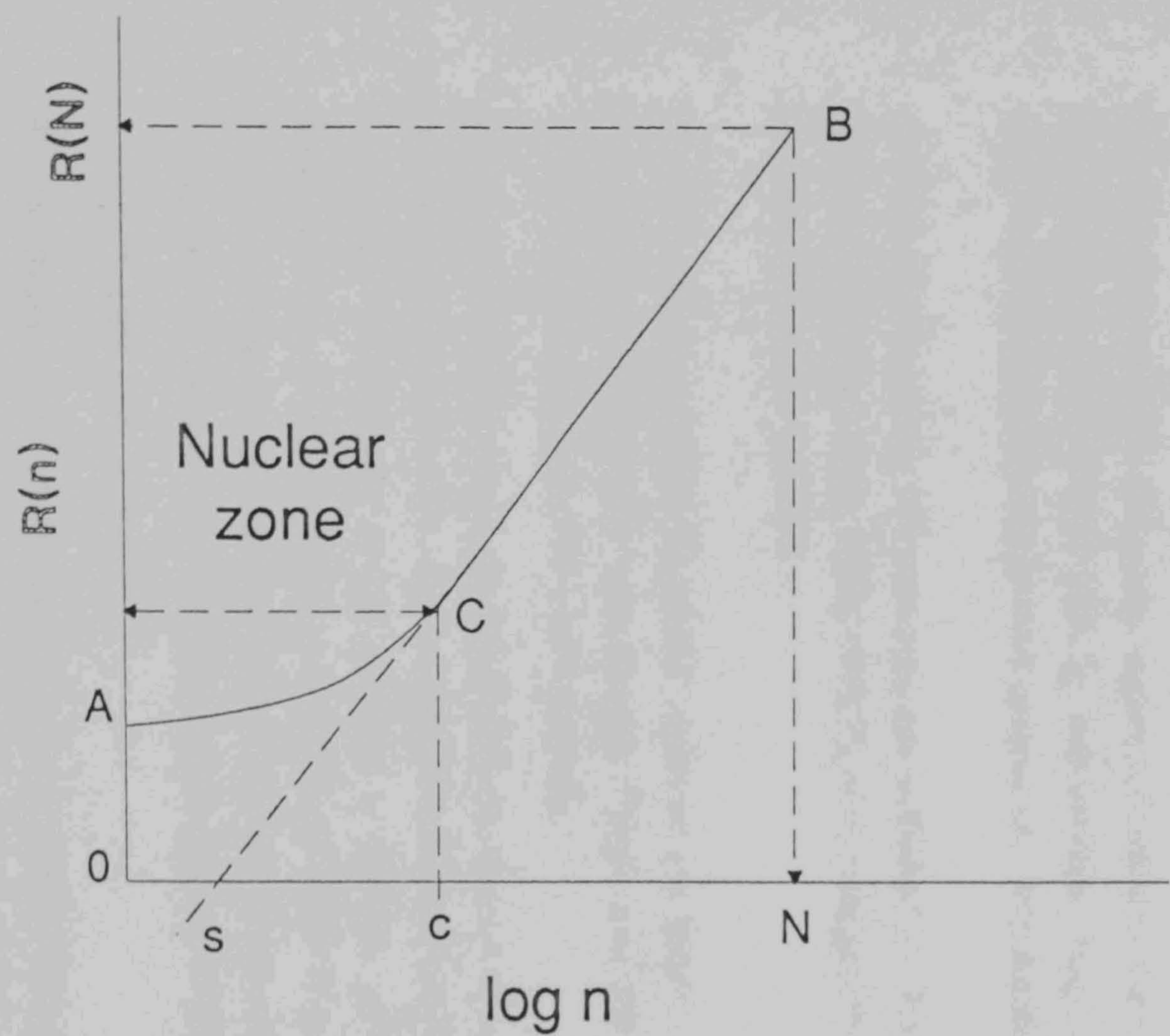


Fig. 6.4.1 Bradford's Distribution (after Brookes, 1969)

To apply Bradford's law to the pharmaceutical sciences area, we choose the following four bibliographies:

(1) 1635 citations from 614 source papers published in a Chinese journal "Pharmaceutical Analysis" (1984-1987); with an average citing rate of **2.7** citations per paper. Citations are from 125 Chinese source journals and 215 foreign source journals. That are from total 340 source journals.

(2) 1070 citations from 124 source papers published in "Chinese Journal of Clinical Pharmacology (1985-1987) " (CJCP); with average citing rate of **8.6**. Citations are from 76 Chinese journals and 224 foreign journals. That are from 300 source journals.

(3) 1930 citations from 106 source papers published in "British Journal of Clinical Pharmacology (Jan. - June, 1984)" (BJCP); with average citing rate of **18.2.** Citations are from 306 source journals.

(4) 9501 references from 90 source papers of the American "Annual Review of Pharmacology (1968-1970)" with average citing rate of **106** (source from Segupta, 1974). Citations are from 779 source journals.

For the four bibliographies, the Bradford's distribution of papers over journals are presented in Appendix 6.4.1 - 6.4.9. **Figure 6.4.2-6.4.5** show the actual and estimated "complete" bibliographs of (1) citations in Chinese journal "Pharmaceutical Analysis" (Fig. 6.4.2); (2) citations in CJCP and BJCP (Fig. 6.4.3); (3) citations in CJCP and references in American journal "Annual Reviews of Pharmacology" (Fig. 6.4.4); and (4) Chinese citations and English citations in CJCP (Fig. 6.4.5).

RESULTS AND DISCUSSION

All the figures show good conformity with Bradford distribution. Only Annual Review of Pharmacology bibliograph (Fig. 6.4.4) shows a significant drop in **N** Which is the total number of periodical title that would be expected to publish paper on the subject. There is expected to be 2193 source journals contributing to the pharmacology field and 14390 papers in a complete bibliography. In fact, the Annual Review of Pharmacology bibliography only covers 779 source journals and 9501 papers. This difference may be caused by the highly selective nature of the Annual Review of Pharmacology which eliminates many relevant papers that the Review believes lack of value.

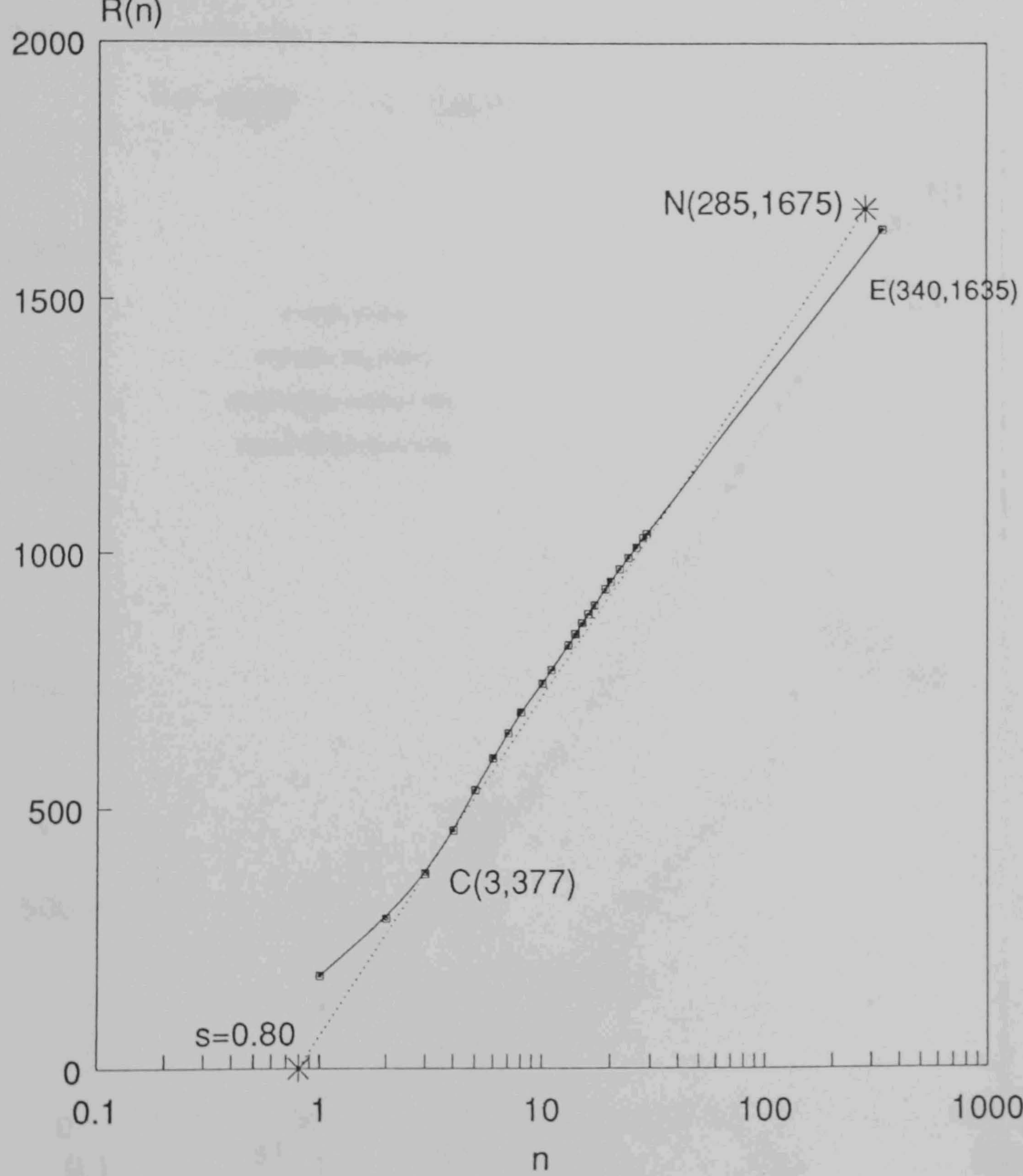


Fig. 6.4.2 Citations in Pharm. Analysis
(1984-1987)

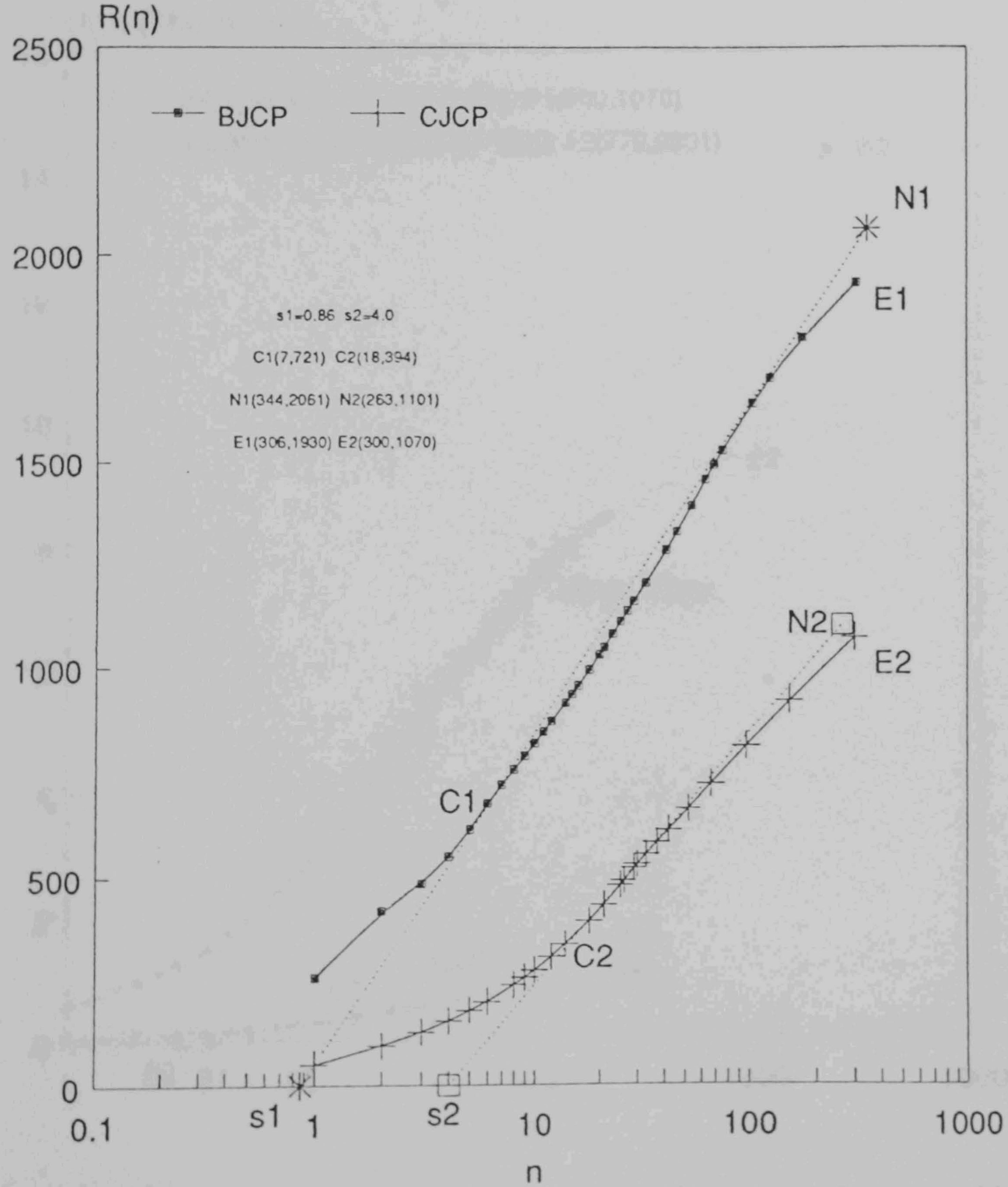


Fig. 6.4.3 Citations in CJCP and BJCP

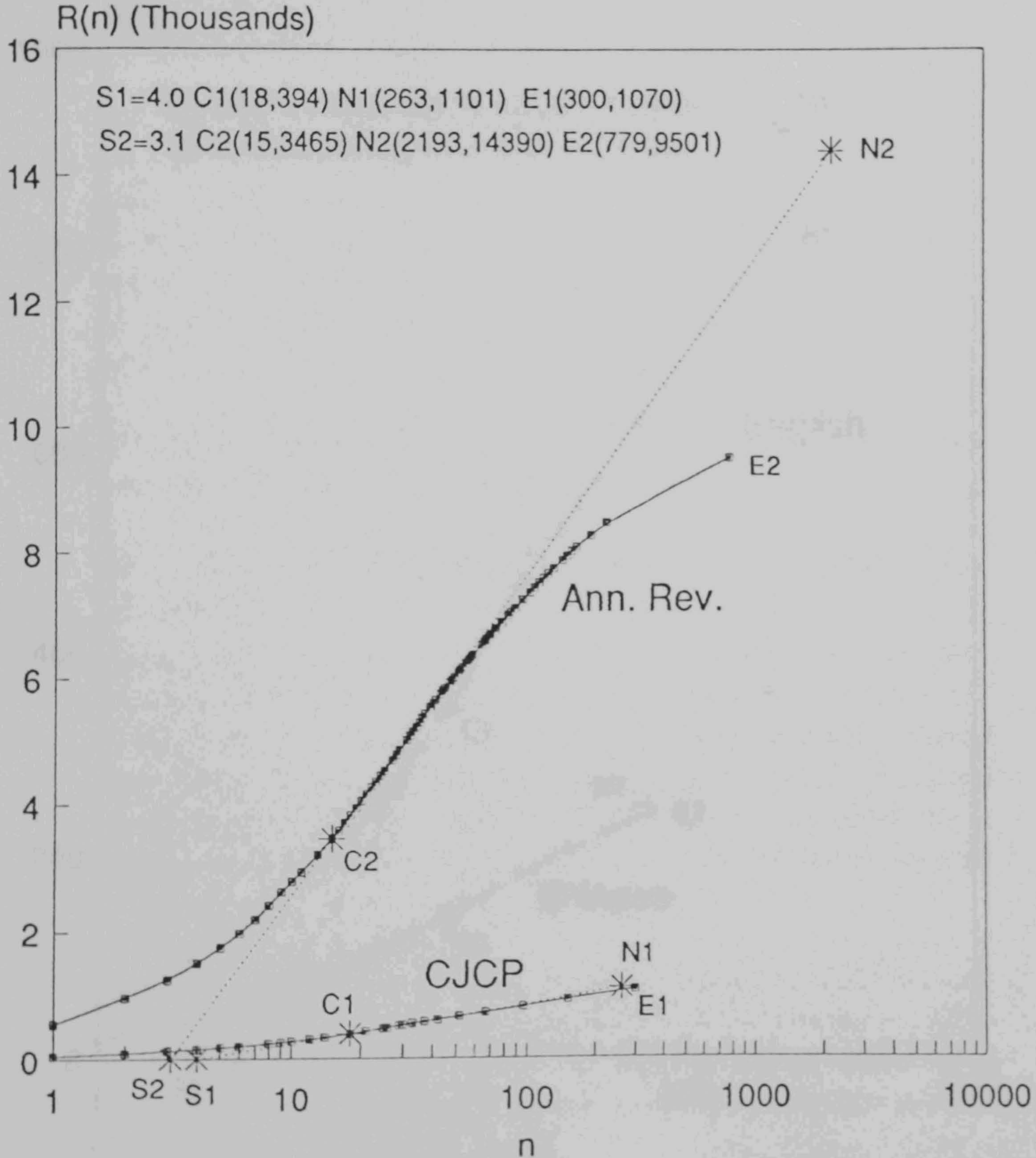


Fig. 6.4.4 Citations in CJCP & Ann. Rev

CJCP:(1985-1987); Ann. Rev.:(1968-1970)

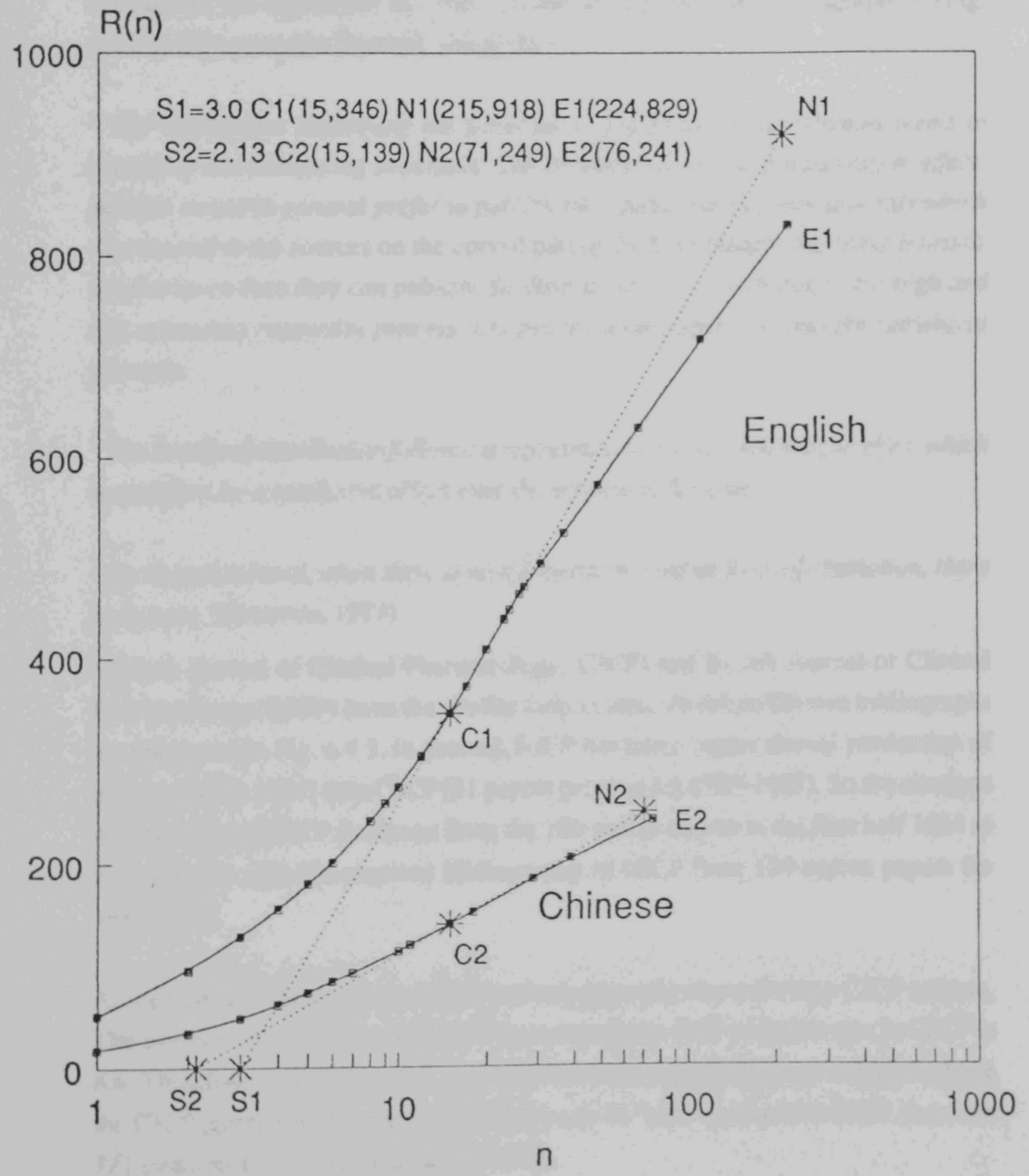


Fig. 6.4.5 Citations in CJCP
(1985-1987)

All the bibliographs demonstrate the "core" journal and "peripheral" journal effect in pharmaceutical areas. Pharmaceutical Analysis has a core of 3 journals (Fig. 6.4.2). CJCP has a core of 18 journals (Fig. 6.4.3). BJCP has a core of 7 journals (Fig. 6.4.3). Annual Review of Pharmacology has a core of 15 journals (Fig. 6.4.4).

To explain the difference in "core" effect among the four bibliographies (Fig. 6.4.2-6.4.5), we quote Brookes' theory first:

" The mechanism underlying the generation of a Bradford distribution seems to consist of two competing processes. The primary process is a bandwagon effect: authors would in general prefer to publish their papers in the core journals which correspond to the sources on the curved part *of the bibliograph. But these journals receive more than they can publish. So their standards of acceptance are high and this secondary restrictive process then pushes some papers out into the peripheral journals.*

" The Bradford distribution follows: it represents an overall bandwagon effect which is modified by a restrictive effect over the sources at the core.

" On the other hand, when there is no competition or other form of restriction, there is no core."(Brookes, 1973)

Chinese Journal of Clinical Pharmacology (CJCP) and British Journal of Clinical Pharmacology (BJCP) have the similar subject area, therefore the two bibliographs are compared in Fig. 6.4.3. In general, BJCP has much bigger annual production of papers (293 in 1984) than CJCP (41 papers per year for 1985-1987). So the citations bibliography of BJCP is chosen from the 106 source papers in the first half 1984 to be compared with the citations bibliography of CJCP from 124 source papers for 1985-1987.

As we have already mentioned BJCP authors generally cite more than CJCP authors. The average citing rate in each BJCP source paper is **18.2** while the rate in CJCP is **8.6**. Therefore, from Fig. 6.4.3, one could find that the BJCP graph is higher above the CJCP graph. Comparing to 394 citations to 18 "core" journals in CJCP, there are 721 citations to 7 "core" journals in BJCP.

Fig. 6.4.3 also shows that **a bigger "core" in CJCP with 18 journals** accounting for 37% of citation comparing **a smaller "core" in BJCP with 7 journals** accounting for 37% of citation. The effect may reflect the difference in subject width covered by BJCP and CJCP which is to be discussed later.

In the case of "Annual Reviews of Pharmacology" (Fig. 6.4.4), the bibliography is more comprehensive than the other three journals in the number of both source journals and citations. There is a relatively big core of 15 journals comparing to CJCP (18 cores), BJCP (7 cores) and Pharmaceutical Analysis (3 cores). The big core also reflects the fact that there is a wide subject coverage in the Annual Review of Pharmacology.

Like "Pharmaceutical Analysis", CJCP also is a Chinese scientific journal. However, the CJCP bibliographs (Fig. 6.4.3 & Fig. 6.4.5) have bigger "cores" whereas the "Pharmaceutical Analysis" bibliograph (Fig. 6.4.2) have smaller one. Here, the difference may also rise from the different subject width covered by the two journals.

According to Brookes' theory, parameter s≤1 is for only narrow scientific subjects, as the subject widens, so does s. A bibliograph in a wider subject area is likely to have a bigger core than a bibliograph in a less wide subject area.

It is generally understand that the pharmacology has the widest subject, clinical pharmacology has the second wide subject and pharmaceutical analysis has the narrow subject, so Annual Review of Pharmacology has the biggest subject parameter (s=3.1) and biggest core (15 cores), the BJCP has the modest subject parameter (s=0.86) and the modest core (7 cores) and Pharmaceutical Analysis has the smallest subject parameter and core (s= 0.8 and 3 cores).

However, it comes the problem that how to explain CJCP has a bigger subject parameter (s=4.0) and a bigger core (core 18) than Annual Review of Pharmacology (s= 3.1 & Core 15), BJCP (s= 0.86 & core 7) and Pharmaceutical Analysis (s= 0.8 & core 3).

The explanation could come only from the subject width of CJCP, BJCP and Annual Review of Pharmacology. The width of a subject is different to different nation's scientists. ***The hypothesis is that if a subject is well developed and the academic level of research work is high in a country, the nation's scientists will make focused information use over subject width.***

Figure 6.4.3 and 6.4.4 show that CJCP has a subject parameter s=4.0, with BJCP s=0.86 and Annual Review of Pharmacology s=3.1. The figures indicate that although CJCP is a specialist journal in clinical pharmacology, its bibliography of citations are from a much wider subject area. It reflects a relatively diffuse information using and citing behaviour by Chinese clinical pharmacological scientists compared with British pharmacologists and clinical pharmacologists.

Clinical Pharmacology is a relatively "young" subject area in China which formally started in the 1979 while in the western countries it started in the late 1960s (see Chapter 3). The younger a subject area is and the lower the academic level is; the broader the scientists' interest might be and the more diffuse information use will happen, because there is no sophisticated framework being widely accepted and adopted in the subject area.

Further analysis also explains a bigger core in CJCP (18 cores) vs. a smaller core in Pharmaceutical Analysis (3 cores). The two journals are all Chinese leading journals in their fields. Apart from the obvious reason that clinical pharmacology is wider than pharmaceutical analysis, the hidden reason may also come from different information using and citing behaviour between Chinese clinical pharmacologists and pharmaceutical analysists. Clinical pharmacology has a shorter history of less than 8 years in China whereas pharmaceutical analysis has a longer history of more than 60 years in China.

Pharmaceutical analysis has already been a sophisticated and mature area in China. The relatively mature status in Chinese pharmaceutical analysis seems to have made the citing behaviour of Chinese pharmaceutical analysists quite different from that of Chinese clinical pharmacologists. It is observed that pharmaceutical analysists cite more Chinese papers than foreign papers comparing to clinical pharmacologists cite more foreign papers than cite Chinese papers. In Pharmaceutical Analysis, 40% of cited journals are Chinese journals; comparing to 24% in CJCP. In Pharmaceutical Analysis, 50% of citations are Chinese papers; comparing to 26% in CJCP.

We may conclude that Chinese clinical pharmacological scientists show more diffuse information use (over subject width) than their British colleagues as well as than their Chinese colleagues in pharmaceutical analysis field, may be caused by the premature status of the clinical pharmacology in China.

The above discussion implies that a nation scientists' information using ability (as reflected from citing behaviour) may be influenced by the academic level or the status of research in the subject field in the country. Lower academic level and premature research status may result in diffuse information using by Chinese clinical pharmacological scientists.

Perhaps a more straightforward demonstration of the concentration and dispersion effect of papers in journals is to show the number of periodicals required to cover a specified fraction (p) of total papers of a subject. **Table 6.4.1-6.4.3**. give the results of **"journal coverage of specified fraction of papers"** from "Pharmaceutical Analysis" Chinese **bibliography** and English bibliography, from CJCP Chinese bibliography and English bibliography, and from "Annual Reviews of Pharmacology" bibliography.

From the above tables, we can see that in the "Pharmaceutical Analysis" bibliographies and "Ann. Rev. Pharmacology" bibliography, 2%-4% of source journals contribute 40% of total papers in the fields, and 80% of total papers are contributed by 26-31% of journals. In the case of CJCP, the concentration and dispersion is not as extreme as in the other two cases ("Pharm. Anal." and "Ann. Rev. Pharmacology"): 80% of Chinese papers are contributed by 49% Chinese journals and 80% of English papers by 43% of English journals.

To compare the third column of **Chinese citations** covered by % of source journals and the sixth column of **English citations** covered by % of source journals in Table 6.4.1 ("Pharmaceutical Analysis"), one could find the relative percentages of source journals covering certain percentages of citations in the two columns with a reasonable degree of unanimity. The same unanimity can also be seen in Table 6.4.2 in the case of CJCP.

The results seems to indicate that major influence on a Bradford's distribution pattern of a specific bibliography is subject related rather than language related. In a Bradford distribution pattern, Chinese scientists *from the same subject area* cite and use Chinese papers in a pattern similar to that when they cite and use English papers.

6.4.2 Average Number of Citations in Each Paper

Generally, Chinese scientists cite far fewer in each periodical paper than their British and western colleagues. According to the study on 1227 Chinese S&T journals, the average number of citations made by each periodical paper in 1989 is **5.4** and in medical and pharmaceutical field the average number of citations is **8.7** (Zhang, 1990). By comparison with the world figure, using "Source Data Listing " of SCI in 1987, the average citations made by each papers in the three thousands source journals is **20.8**.

Table 6.4.1 Source Journal Coverage By Percentage -in bibliographies of "Pharmaceutical Analysis"

Chinese citation bibliography			English citation bibliography		
% of papers	no. of sources	% of sources	% of papers	no. of sources	% of sources
100	145	100	100	130	100
80	38	26	80	40	31
60	12	8	60	17	13
40	3	2.1	40	5	4
20	0.85	0.6	20	1.8	1.4

Table 6.4.2 Source Journal Coverage By Percentage - in bibliographies of CJCP

Chinese citation bibliography			English citation bibliography		
% of papers	no. of sources	% of sources	% of papers	no. of sources	% of sources
100	71	100	100	215	100
80	35	49	80	92	43
60	18	25	60	39	18
40	9	13	40	17	8
20	4	6	20	7	3

Table 6.4.3 Source Journal Coverage By Percentage - in bibliography of "Annual Review of Pharmocology"

% of papers	no. of sources	% of sources
100	2193	100
80	594	27
60	160	7
40	43	2
20	12	0.5

Another example is the comparison of Chinese Journal of Clinical Pharmacology (CJCP) and British Journal of Clinical Pharmacology (BJCP).

106 source papers in first half year of BJCP in 1984 had cited 1930 papers, with an average citing rate of **18.2** citations in each source paper.

By comparison, 124 source papers in CJCP (1985-1987) had cited 1070 papers, with an average citing rate of **8.6** citations in each source paper.

The reasons for less citations by Chinese papers are complex. One possible influence may be the lower information accessing ability to world S&T information, comparing to the situation in UK and developed countries. Other reasons may include the difference in scientists' citing habits and the difference in the academic level of research between the two countries.

6.4.3 Language of Citations

It is not surprising that because English is the world scientific language, British and American authors would mostly cite papers in their native language, Chinese authors have to read and cite more English language papers than their own language papers.

For example, 106 source papers in BJCP (Jan. - June, 1984) had cited 1930 citations, of which more than 90% are English language citations. By comparison, there are 1070 citations from 124 source papers in CJCP (1985-1987), of these citations 72% are in English and 26% in Chinese.

However, the ratio of Chinese citations vs. foreign language citations by Chinese journals varies accordingly.

According to ISTIC survey on 2870 papers published in Chinese pharmaceutical journal in 1989, the average citation number in each paper is 8, of which 3.8 are Chinese citations and 4.2 are foreign language citations (Zhang, 1990).
The figures show a balanced citation pattern between Chinese and foreign language.

In Pharmaceutical Analysis, as being described above, 50% of citations are Chinese papers; comparing to 26% of citations are Chinese citations in CJCP.

Above all, that Chinese scientists have to use over 50% of literature in foreign language whereas British scientist use over 90% of literature in the native language may reflect the difference in the S&T position and the S&T impact in the world between the two countries.

6.4.4 Highly Cited Authors

Although there is no guarantee that the less productive authors are nonentities and the more productive authors are distinguished scientists, there is a strong correlation between productive authors and highly cited authors. For example, one study reported that among the top 30 highly productive authors, 11 of them are also found to be at the top 30 highly cited authors in that field (Pharmaceutical Analysis in China) (Yuan, 1989).

It is generally believed that Chinese "star" authors mainly have great impact on Chinese scientific society rather than on the world scientific society. **Table 6.4.4** shows how is the impact from Chinese authors on Chinese scientists.

Table 6.4.4 28 "Star" Chinese Authors' Impact on Chinese Scientists (in Chinese journal "Pharmaceutical Analysis" 1981-1987)

citations received by one author	26	19	15	13	12	11	10	9	8	7
No. of cited authors	1	1	2	1	1	2	1	5	6	8

*total 28 "star" authors

On searching for those 28 "star" authors in SCI 1987 edition, we find that only three of them have been cited in that year, one has been cited 7 times, the second twice, and the third once. This implies that Chinese authors have little impact on the world.

On the contrary, British scientists generally have much more impact on the world scientific society than Chinese scientists. We chose 8 leading British scientists in the same field (Pharmaceutical Analysis) as the above 28 Chinese authors (Liu, 1990). Using SCI 1987 edition, we search for the 8 British "star" authors and list the number of citations they have received in 1987 from the world 3200 major journals (**Table 6.4.5**).

Table 6.4.5 Eight British "Star" Authors' Impact on World Scientists in SCI 1987

citations received by one author	72	68	63	47	28	13	10	4
No. of cited authors	1	1	1	1	1	1	1	1

It is clear that British scientists, with the top author getting 72 citations in 1987, have much greater impact in the world scientific society than Chinese scientists among whom the top author gets only 7 citations in 1987.

In all Chinese S&T fields, Shanghai Institute of Biochemistry of Academia Sinica, and Shanghai Institute of Material Medical of Academia Sinica are ranked at the first and the sixth highly cited Chinese research institutes, according to SCI citations to their work during the period of 1985-1987 (Zhang, 1990).

Compared with the world leading pharmaceutical companies, however, the top two Chinese pharmaceutical institutes have produced far fewer world class papers and received far fewer citations from world journals(**Table 6.4.6 a & b**).

The above facts may reflect that the academic level of research in China is relatively low comparing to that in the UK.

6.4.5 Highly Cited Journals

Now let us look at another feature of scientific journal literature - **the quantity vs. the quality.**

"We have now a world list of some 50,000 scientific periodicals that have been published; these have produced a world total of about six million scientific papers, and an increase at the approximate rate of at least half a million a year" (Price, 1963).

The exponential growth in S&T literature has inevitably brought in the problem on quality control of journal papers. According to ISTIC survey in 1990, only 1227 of the total three thousand Chinese journals are up to the national editing standards. Only 82% of total Chinese journals have paper title in English, 68% of journals have English abstracts, and only 56% of journals give full description of citations or references (Zhang, 1990).

Table 6.4.6a Leading Chinese Pharmaceutical Institutes*
-papers published in SCI world journals and citations received in SCI (1985-1987)

rank by papers published	no. of papers	R&D institute	no. of citations	rank by citations in SCI
1	275	Shanghai Institute of Biochemistry	121	1
6	109	Shanghai Institute of Materia Medica	47	6

* The institutes at 2nd, 3rd, 4th, and 5th are non pharmaceutical institutes.

Table 6.4.6b International Pharmaceutical Companies Ranked by Articles and Citations (SCI 1970-1974)
Source: (Koenig, 1983)

rank	company	papers	rank	company	citations
1	Roche	1732	1	Roche	4736
2	Lilly	1051	2	Lilly	1980
3	Upjohn	950	3	Upjohn	1605
4	Merck	785	4	Merck	1491
5	Warner L.	646	5	Abbott	1106
6	Smith K.	498	6	Warner L.	846
7	Abbott	455	7	Smith K.	802
8	Pfizer	451	8	Searle	757
9	Searle	399	9	Pfizer	640
10	Schering	325	10	Syntex	605

In general, the refereeing technique, which has been adopted in scientific community in the world for long time, measures the quality of scientific work, not just on a binary good or bad scale, but on a graduated scale from publication in one of the best journals down to publication in non-refereeing journals and finally to outright rejection. It is generally accepted that there is a "pecking order" of journals within any given subject area (Garfield, 1972). **Generally, the distribution of a nation's scientific journals in the world journal "pecking order" reflects the nature of quality vs. quantity in the nation's scientific literature.**

If a journal is relatively highly cited by scientists in the subject area, it is considered having greater impact in the field. SCI defines the following "impact factor" of a journal:

"Impact factor is a measure of frequency with which the "average article" in a journal has been cited in a particular year. Thus the 1988 impact factor of journal X would be calculated by dividing the number of all SCI source journals' 1988 citations of articles journal X published in 1986 and 1987 by the number of source items it published in 1986 and 1987 (SCI Vol. 19, 1988)."

Since 1973 when SCI introduced the Journal Citation Reports (JCR) which includes ranking of 3200 its sources journals and one thousand non-source journals by citations and by impact factors; it has provided a more convenient tool for evaluating scientific journals in the world, particularly in the English language world.

Unfortunately, so far, due to the language barrier, SCI has only covered ten Chinese published English language journals. Among them two are pharmaceutical relevant, they are: ACTA Pharmacologica Sinica (APS) and Scientia Sinica B (SSB).

To compare with the two Chinese leading journals in the field, we choose five major western journals:

1. Clinical Pharmacology and Therapeutics (CPT) ,
2. British Journal of Clinical Pharmacology (BJCP),
3. European Journal of Clinical Pharmacology (EJCP),
4. Journal of Clinical Pharmacology (JCP),
5. International Journal of Clinical Pharmacology and Therapy (IJCPT).

Using the Journal Citation Reports (JCR) 1988 edition, we have the two Chinese journals and five western journals ranked by times cited in 1988 SCI (**Table 6.4.7**). The above results show that Chinese journals have received less citations and have less impact than their western counterparts. The implication is that the academic level of research in China is relatively low comparing to that in the UK and other western developed countries.

Table 6.4.7 Journals Ranked by Times Cited in 1988 SCI

rank	journal	citations in 1988 to all years	citations in 1988 to 1987+1986	source items in 1987+1986	impact factor
174	CPT	8098	1176	372	3.161
257	BJCP	6063	1317	523	2.518
395	EJCP	3952	833	548	1.520
970	JCP	1438	355	292	1.147
1609	IJCPT	675	112	275	0.407
2807	APS	211	42	302	0.139
3015	SSB	166	42	267	0.157

* the total rank in JCR 1988 is 4375.

On the other hand, it is clear that the most important journals in the world also have great impact in China. **Table 6.4.8 and 6.4.9** show the top 30 and the top 20 highly cited journals in Chinese Journal of Clinical Pharmacology (CJCP) and in BJCP respectively.

Among the top 30 high cited journals in CJCP, there are 6 Chinese journals, 3 British journals and the others being mainly American journals.

Among the top 20 high cited journals in BJCP, there are 6 British journals and none Chinese journals. The largest proportion of journals is from American.

There are five important western journals have been highly cited among the top ten by both CJCP and BJCP.

Table 6.4.8 Journals Ranked by Citations Received during 1985-1987 in CJCP

rank in CJCP	rank in BICP	journal	citations received in 1985-1987 in CJCP	SCI-JCR impact factor	SCI-JCR rank by impact factors
1	2	CLIN. PHARM. THER. (US)	51	3.161	224
2	13	AM. J. CARDIOL.	44	2.619	321
3	4	NEW ENG.J. MED. (US)	33	21.148	7
4	3	LANCET (UK)	27	14.48	17
5	>20	AM. HEART J.	25	1.801	606
6	>20	ANN. INTERN. MED. (US)	21	8.467	39
7	10	CIRCULATION (US)	20	6.676	58
8	>20	J.A.M.A. (US)	20	5.283	86
9	-	ZHONG HUA YI XU ZA ZHI (CHINA)	18	-	-
10	1	B.J.C.P. (UK)	17	2.518	343
11	9	J. PHARMA. SCI. (US)	16	1.354	894
12	-	GUO WAI YI XU (CHINA)	16	-	-
13	5	BRIT. MED. J.	15	3.136	232
14	>20	AM. J. MED.	15	2.731	292
15	-	ANTIBIOT. CHEMO. (Switzerland)	14	-	-
16	7	CLIN. PHARMACO-KINETICS (US)	14	3.393	193

continued

17	>20	INTERN. ARCH. ALLER. APPL. (US)	14	1.311	934
18	-	CJCP (CHINA)	14	-	-
19	15	J. CHROMATO. (Netherland)	13	1.414	838
20	17	J. PHARMACOKI. BIOPHARM. (US)	13	1.519	754
21	-	KANG SHENG SU (CHINA)	13	-	-
22	>20	CONTRACEPTION (US)	12	0.76	1672
23	>20	MUTATION RES. (US)	12	1.86	578
24	>20	NEUROLOGY (US)	12	2.965	251
25	-	YAO XU XU BAO (CHINA)	12	-	-
26	-	ZHONG GUO YI YUAN YAO XU ZA ZHI (CHINA)	11	-	-
27	>20	DRUGS (New Zealand)	10	1.544	735
28	>20	J ANTIMICROB CHEMOTHER (US)	10	2.365	386
29	>20	CLIN. CHEM. (US)	10	1.941	534
30	6	EURO. J. CLIN. PHARMOCOLOGY (Germany)	9	1.520	753

Table 6.4.9 Journals Ranked by Citations Received during Jan.-June, 1984 in BJCP

rank in BJCP	rank in CICP	journal	citations
1	10	B.J.C.P. (UK)	260
2	1	CLIN. PHARM. THER. (US)	160
3	4	LANCET (UK)	66
4	3	NEW ENG.J. MED. (US)	65
5	13	BRIT. MED. J.	64
6	30	EURO. J. CLIN. PHARMOCOLO. (Germany)	61
7	16	CLIN. PHARMACOKINETICS (US)	45
8	>30	CLIN. SCIENCE (UK)	36
9	11	J. PHARMA. SCI. (US)	33
10	7	CIRCULATION (US)	30
11	>30	J. PHARMA. EXP. THER. (US)	28
12	>30	J. CLIN. INVEST. (US)	24
13	2	AM. J. CARDIOL.	22
14	>30	J.CLIN. ENDOCRINAL METAB. (US)	22
15	19	J. CHROMATO. (Netherland)	21
16	>30	J.CARDIO. PHARMACO. (US)	20
17	20	J. PHARMACOKI. BIOPHARM. (US)	19
18	>30	LIFE SCIENCE (UK)	19
19	>30	J LAB. CLIN. MED. (US)	18
20	>30	BRIT. J. PHARMACOLOGY	18

There are 12 important western journals have been highly cited among the top 20 by BJCP authors and among the top 30 by CJCP authors.

Some differences in western journal ranking in CJCP and BJCP may be caused by the different emphases on research in the two countries. For example, the journal *Contraception* has been ranked at the 22nd in CJCP but ranked after 60th in BJCP is because the research priority in that subject in China.

In 1988, SCI-JCR listed total 4233 world scientific journals ranked by impact factors. The top 24 western journals in CJCP all have high ranks in SCI. There are two with rank above the 17th; six ranking above the 232nd; six ranking above the 386th; nine ranking above the 934th (Table 6.4.8). The top 24 western journals highly cited by Chinese clinical pharmacologists are among the top 1000 world journals.

The result that Chinese authors cite more foreign papers than Chinese papers, and rank foreign journals higher than Chinese journals is conformed by the result in Chapter 5 that 90% of Chinese scientists regard foreign information as a very important information source and majority of senior scientists regard foreign information more important than Chinese information. This may reflect that the academic level of research in China is relatively low than that in developed countries.

6.5 The Aging of Scientific Literature

Another interesting topic, which reflects the information using ability of scientists, is the literature aging phenomena. Literature aging is generally recognized by scientists as well as by bibliometric researchers as the reduction in the use of literature over time.

The phenomena has been defined by Line and Sandison (1974) as the "decline over time in validity or utility of information".

Griffith (1979) further summarised the aging phenomena:

"When a scientist gets a new publication, he exhausts the usefulness contained in it and makes himself acquainted with the current prevailing trend in his specific field while reading. After the integration of the usefulness into his own activity, and when his endeavour is completed, the results will appear as another publication. At this time what he has learned from his previous reading turns out to be cited documents. This implies

the contents of published documents gradually become of negligible scientific interest as they are read; the citing literature makes them old by gradually exhausting portions of their total usefulness as cited papers."

The factors responsible for the aging usually fall into the two categories:

1. Literature-based factors: such as the growth of literature, subjects of the literature, types of literature etc.

2. User-based factors: such as users' ability in searching, accessing and assimilating information or literature; ability in foreign languages: etc.

In this study we assume the literature based variables as *ceteris paribus*.

B.C. Brookes developed a straight forward technique of measuring aging as follows (Brookes, 1973):

The measure requires a sample of at least 2000 citations from the literature of the subject published within some specified year. The frequencies of citations to earlier papers of the same literature are then noted, taking the year as the unit. These frequencies are then cumulated in a table so that it is possible to read off how many citations were made to each specified year or earlier. The frequencies so cumulated, reducing year by year as the citations to still earlier years decline in frequency, are then plotted against their corresponding dates on semilog paper as shown in **Figure 6.5.1.** In general, it will be found that the plotted points fall steadily downwards on a straight line. This implies that literature ages exponentially.

The next step is to draw the best possible straight line through the linear part of the graph and to extend it to the edges of the graph paper. A second straight line QA is then drawn parallel to the first straight line and this second line becomes the means by which the annual aging rate (a) can be read. Apart from annual aging rate (a), the other important indicator of aging is " half-life" (h) - a phenomena borrowed from physics - which means the time during which half the currently active literature was published (Line, 1970). According to Brookes' empirical law of aging, literature ages exponentially and has a distribution

$$U(t) = U(0) \times a^t \quad (1)$$

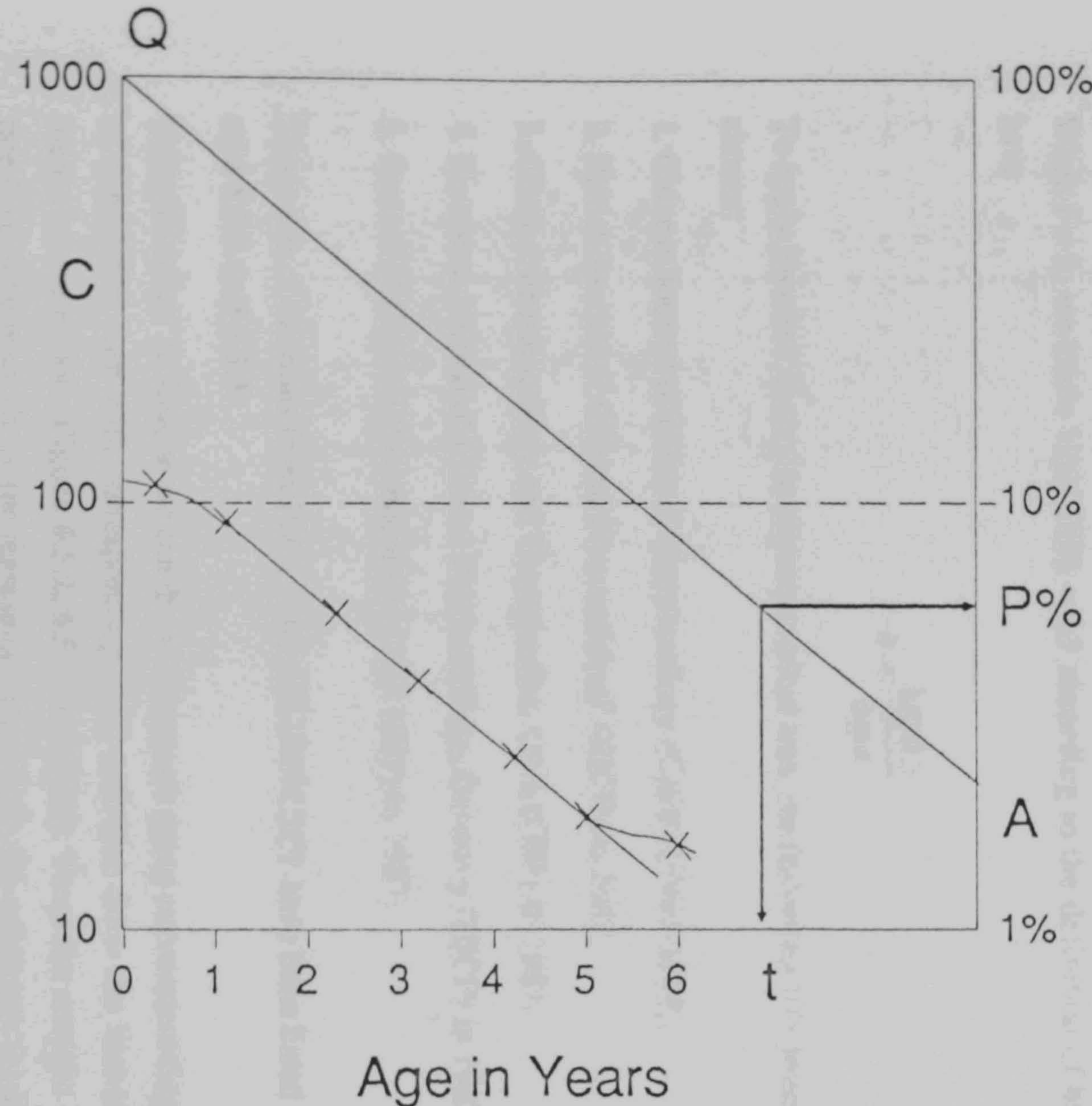


Fig. 6.5.1 Graphical Method of Estimating Obsolescence
(after Brookes, 1973)

Where U(0) is the total number of cumulative citations and U(t) is the presumed number of cumulative citations during the t years, a is the annual aging rate.

So that
$$\frac{U(t)}{U(0)} = a^t \qquad (2)$$

then
$$\log\left[\frac{U(t)}{U(0)}\right] = t \times \log a \qquad (3)$$

When t = h, we know U(t)/ U(0) = 0.5 according to the definition of half-life; so we have

$$h = \frac{\log 0.5}{\log a} \qquad (4)$$

To apply Brookes' theory to pharmaceutical area, the following five journals have been chosen:

1. Chinese Journal of Clinical Pharmacology (CJCP) (1985-1987);
2. British Journal of Clinical Pharmacology (BJCP) in 1987;
3. Clinical Pharmacology and Therapeutics, USA (CPT) in 1987;
4. European Journal of Clinical Pharmacology, Germany (EJCP) in 1987;
5. Journal of Clinical Pharmacology, USA (JCP) in 1987;

Three sets of citations from 1985, 1986 and 1987 CJCP have been listed in **Table 6.5.1 and 6.5.2 and 6.5.3**.

Using Brookes' technique we can draw a literature aging curve according to each series of cumulative sum with corresponding ages; and then draw the best straight line by means of regression (**Figure 6.5.2, 6.5.3 and 6.5.4**). From the straight line, the aging rate (a) can be read. Or by the regression calculation, the aging rate (a) and half-life (h) can be calculated.

The **a** and **h** of citations in CJCP is presented in **Table 6.5.4, Table 6.5.5 and Table 6.5.6.**

Table 6.5.1 Citation in CJCP (1985)

Age	Year	Chinese Citation		English Citation		Total Citation	
		number	sum	number	sum	number	sum
0	1985	14	99	1	286	15	396
1	1984	18	85	32	285	54	381
2	1983	19	67	37	253	61	327
3	1982	13	48	43	216	57	266
4	1981	10	35	40	173	50	209
5	1980	6	25	23	133	30	159
6	1979	9	19	15	110	24	129
7	1978	3	10	18	95	21	105
8	1977	1	7	10	77	11	84
9	1976	3	6	6	67	9	73
10	1975*	3	3	61	61	64	64

* 1975 or earlier

Table 6.5.2 Citation in CJCP (1986)

Age	Year	Chinese Citation		English Citation		Total Citation	
		number	sum	number	sum	number	sum
0	1986	10	76	6	306	16	387
1	1985	15	66	15	300	30	371
2	1984	10	51	20	285	30	341
3	1983	12	41	29	265	41	311
4	1982	8	29	27	236	35	270
5	1981	11	21	33	209	44	235
6	1980	2	10	22	176	25	191
7	1979	1	8	17	154	19	166
8	1978	3	7	16	137	19	147
9	1977	2	4	30	121	33	128
10	1976*	2	2	91	91	95	95

*1976 or earlier

Table 6.5.3 Citation in CJCP (1987)

Age	Year	Chinese Citation		English Citation		Total Citation	
		number	sum	number	sum	number	sum
0	1987	4	77	2	238	6	317
1	1986	7	66	14	236	21	311
2	1985	11	59	32	222	43	290
3	1984	11	48	15	190	27	247
4	1983	9	37	18	175	27	220
5	1982	5	28	18	157	24	193
6	1981	12	23	14	139	26	169
7	1980	6	11	13	125	19	143
8	1979	2	5	13	112	15	124
9	1978	1	3	13	99	15	109
10	1977*	2	2	86	86	94	94

*1977 or earlier

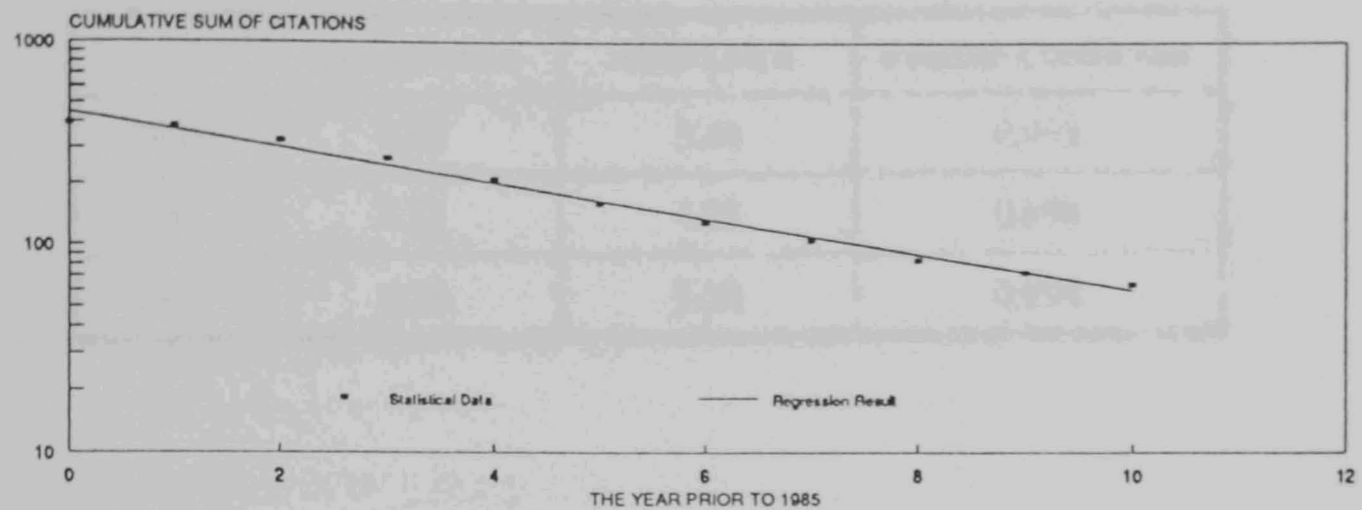


Fig. 6.5.2 Aging Analysis
Citations in CJCP (1985)

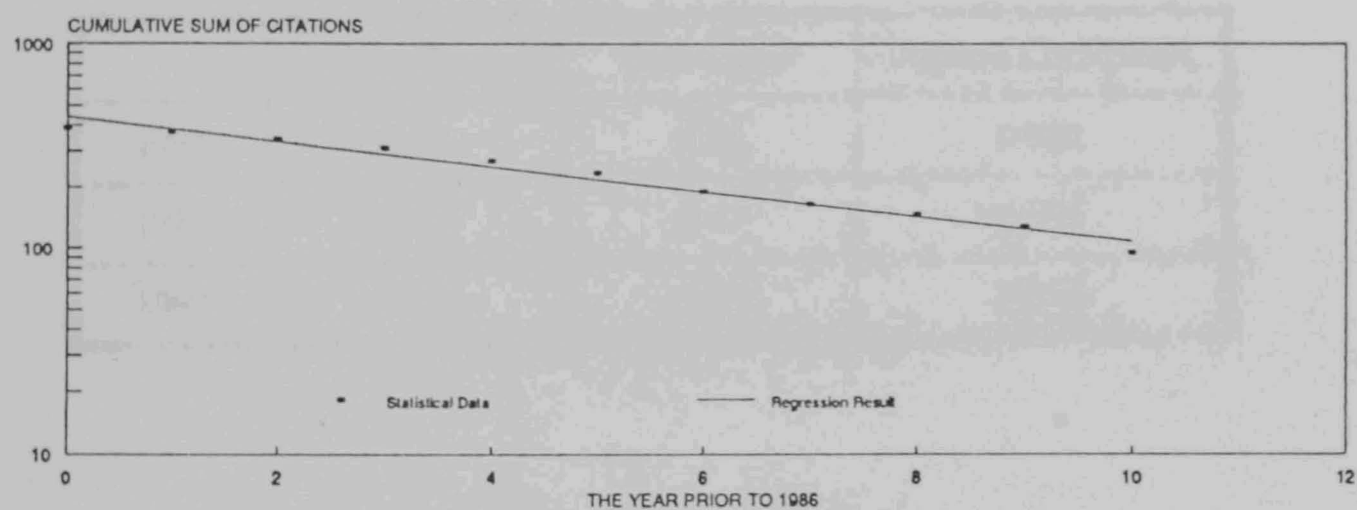


Fig. 6.5.3 Aging Analysis
Citations in CJCP (1986)

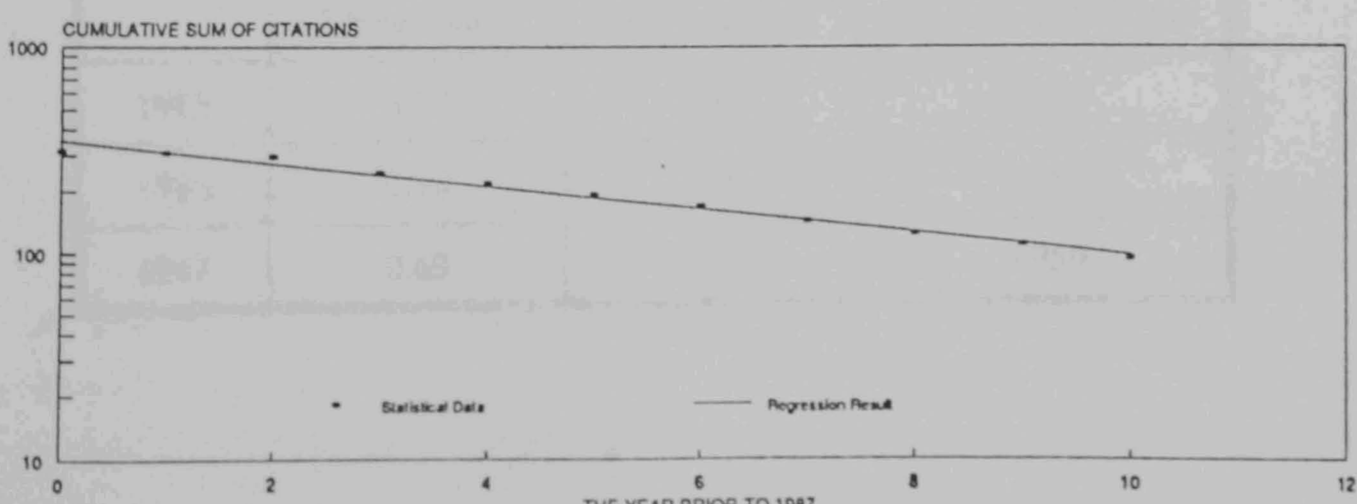


Fig. 6.5.4 Aging Analysis
Citations in CJCP (1987)

Table 6.5.4 Literature Aging Rates, Half-Lifes and Pearson Correlation Coefficents
(Citations in CJCP)

	Aging Rate *a*	Half-Life *h*	Pearson Coefficient
1985	0.82	3.44	0.995
1986	0.87	4.95	0.988
1987	0.88	5.38	0.994

Table 6.5.5 Literature Aging Rates, Half-Lifes and Pearson Correlation Coefficents
(English Citations in CJCP)

	Aging Rate *a*	Half-Life *h*	Pearson Coefficient
1985	0.84	3.98	0.992
1986	0.89	5.74	0.980
1987	0.90	6.53	0.994

Table 6.5.6 Literature Aging Rates, Half-Lifes and Pearson Correlation Coefficents
(Chinese Citations in CJCP)

	Aging Rate *a*	Half-Life *h*	Pearson Coefficient
1985	0.70	1.92	0.992
1986	0.70	1.92	0.987
1987	0.69	1.86	0.959

Generally, fast aging results from focused use by the more effective information processing while slow aging results from diffuse use by less effective information processing (Griffith, 1979).

From Table 6.5.4- 6.5.6, we find in general, Chinese authors cite more recent Chinese literature than they cite English literature. Or one may say that they *"age"* Chinese papers quicker than they *"age"* English papers. On one hand, it reflects the "shorter life" of Chinese S&T literature, which is not surprised because of the generally short history of Chinese modern S&T and the uneven recent development during the 1960s and 1970s. On the other hand, it may also indicate that Chinese scientists can access and absorb Chinese information more effective than English information.

There are differences in aging speed in CJCP among the three years too. It seems that Chinese scientists age literature the quickest in 1985, the modest in 1986 and the slowest in 1987(Table 6.5.4). This may reflect the different information use and cite patterns among eminent and ordinary Chinese scientists.

Because CJCP was newly founded in 1985, it is understandable that the editors collected more papers from prominent or "star" authors in the first year than in the second and the third year. The "star" authors are those who are among the top 40 highly cited, highly citing and highly productive authors in the field in China. With the time passing by, the proportion of "star" authors in CJCP had been decreasing while the proportion of general authors increasing, so that more scientists could get opportunity to publish in CJCP. (Lu, 1990) **(Table 6.5.7).**

Table 6.5.7 Structure of Authorship in CJCP

Year	General Authors	Star Authors
1985	71%	29%
1986	74%	26%
1987	86%	14%

From Table 6.5.4-6.5.7, we find in CJCP from 1985 to 1987, as the proportion of "star" declined, the literature aging speed has been slowed down. It might suggest that the eminent or "star" scientists cite more recent literature or *"age"* literature quicker than the ordinary scientists. According to Griffith (1979) *"the fast aging results from focused use by the more effective information processing core, whereas slow aging results from* *diffuse use by broad scientific community"*, the eminent authors in CJCP represent the core or centre of information processing in the subject field. they access and absorb information more effective than ordinary scientists.

Table 6.5.4 "total citations in CJCP" shows that the same trend- *literature aging being slowed down* from 1985 to 1987- also applies to "English citations in CJCP" (Table 6.5.5) but not to "Chinese citations in CJCP" (Table 6.5.6).

This may reflect that difference in information use and cite between eminent and ordinary Chinese scientists mainly lays in foreign information use and cite.

To compare the literature aging patterns between Chinese scientists and their western colleagues, we list the citations by BJCP, CPT, EJCP and JCP in 1987 comparing with the CJCP citations in 1987 (**Table 6.5.8**). The comparison shows in general, western authors cite more recent literature or *"age"* literature a little faster than Chinese authors. This result, at the first sight, seems contradictory to the result of user studies in Chapter 5. It is reported that less than 40% of Chinese scientists use literature of ten years old, compared to 100% British scientists; less than 10% of them use literature of 20 years old, compared to more than ninety percent of British scientists; the Chinese figure of using literature of more than 30 years old is very small - only 3% of Chinese scientists in comparison with 60% of British (see Chapter 5). In fact the fast aging rate by British authors in BJCP reflects only the statistical effect of the concentration in use or citing the recent literature. Such a statistical result does not exclude dispersion of citations over a long time span.

Table 6.5.8 Literature Aging Rates, Half-Lifes and Pearson Correlation Coefficents for CJCP, BJCP, CPT, EJCP and JCP in 1987

Journal	Aging Rate *a*	Half-life *h*	Pearson Coefficent
CJCP	0.88	5.38	0.994
BJCP	0.85	4.25	0.994
CPT	0.86	4.65	0.992
EJCP	0.86	4.65	0.987
JCP	0.86	4.65	0.992

Comparing to Chinese scientists, the western scientists information use and citing behaviour may be described as: they use wider time span of scientific literature, they cite more papers in their work, they "age" literature faster. All these may reflect that compared with Chinese scientists, the western scientists are more effective in using information.

6.6 Concluding Notes

1. Generally, Chinese scientific journal capacity in disseminating the nation's R&D results is much lower than that of the British scientific journal. The evidences include

(1). there are not enough journals for Chinese scientists to publish their work; China has a S&T manpower of 7.8 million which is 35 times the UK figure whereas the two countries have a similar number of scientific journals;

(2). the average refereeing and editing time for submitted journal paper in China is 1.5-2 times the UK figure;

(3). assuming only senior Chinese scientists as potential authors then the average publication rate is **one** paper per scientist per year in China; comparing to 2-3 papers per academic staff per year in UK universities;

(4). the average number of papers per journal per year in China is 100 compared to 171 in the UK.

2. Because the predominant position of English language in world scientific literature and the leading position of medicines research by British scientists for several decades, it is safe to say that all journal papers by British scientists are disseminated at the world communication circuit.

However, it must note that 4% of Chinese papers in world journals and 10% of Chinese papers in world secondary publications do not indicate that only such proportion of Chinese literature are at the same academic level as all British journal papers. It only indicate that **Chinese scientists have a much smaller capacity in disseminating information** to the world **than British scientists.**

3. A standard of "eminence" requires an eminent Chinese scientist having published **3-4 non-Chinese papers** in world journals within one year. Under such a standard, it is estimated that there are several hundred such Chinese scientists currently. They account for **0.1%** of 400,000 Chinese scientific authors or **0.005%** of total 7.8 million S&T workers in China.

The most prestigious of the UK learned societies is the Royal Society with 1000 fellows currently. Those scientists elected Fellows of the Royal Society (FRS) are regarded as the most eminent scientists in the UK. They account for 0.4% of total 220,000 S&T workers in the UK. The average productivity for a FRS is 3 papers per year in a life time. It is noted that a sample of eminent Chinese scientists have their peak publishing period starting from their work or study abroad. This may be related to better information communication condition in the West.

Conclusions 4-7 show that Chinese scientists information using ability is lower than British scientists:

4. That Chinese clinical pharmacological scientists show more diffuse information use (over subject width) than their British colleagues as well as than their Chinese colleagues in pharmaceutical analysis field, may be caused by the premature status of the clinical pharmacology in China.

The information using capabilities of scientists from one nation (as reflected from citing behaviour) may be influenced by the academic level or the status of research in a subject field in the country. Lower academic level and premature research status may result in diffuse information using by Chinese scientists in clinical pharmacology.

5. Chinese scientists cite much less in their work than western scientists. The average citation rate in Chinese S&T journals is 5.4 citations per paper comparing to 20.8 in the world journals covered in SCI. Another example is that CJCP has an average citation rate of 8.6 whereas BJCP has a rate of 18.2. The reasons for less citations in Chinese papers are complex. One possible influence may be the lower information accessing ability especially to world S&T information, comparing to the situation in UK and other developed countries.

6. Chinese scientists have to use over 50% of literature in foreign language whereas British scientist use over 90% of literature in the native language. This agrees with the user study result that Chinese senior scientist reported relying on foreign literature more than on Chinese literature. Greatly relying on foreign language literature means great difficulty in using information by Chinese scientists.

7. Generally, fast aging results from focused use by the more effective information processing while slow aging results from diffuse use by less effective information processing.

Aging analyses indicate

(1) Chinese scientists can use and absorb Chinese information more effectively than they use and absorb foreign information.

(2) The eminent Chinese scientists represent the centre of information processing or using in the subject field. They use and absorb S&T information especially foreign language information more effectively than ordinary Chinese scientists.

(3) Comparing to Chinese scientists, British scientists use wider time span of scientific literature, they cite more papers in their work, they "age" literature faster. All these may reflect that compared with Chinese scientists, British scientists are more effective in using information.

Conclusion 8-9 may reflect that comparing to the leading position of UK, China has very small impact on medicines research in the world.

8. Chinese eminent authors mainly have great impact on Chinese scientific society rather than on the world scientific society. By comparison, British eminent scientists have major impact on the world scientific society.

9. It is generally accepted that there is a "pecking order" of journals within any given subject area. In such a pecking order, Chinese scientific journals are ranked much lower than British and western journals; because Chinese journals receive much less citations and have less impact in the world than British and western journals.

Chapter 7 Pharmaceutical Information Flow Infrastructure in Britain

A nation's pharmaceutical activity normally consists of the following elements - R&D, manufacturing, marketing, rational use of drug, legislation and regulation; and with the following sectors involved- the industry, academic institutions, national health and care system, and government authority on medicine safety. Pharmaceutical information flow is associated with pharmaceutical activity in a country. Within the pharmaceutical industry, the information flow infrastructure is just like the nerve system in a human body, commanding every action of the body.

In this thesis we define pharmaceutical information as "the information related to pharmaceutical research and development and pharmaceutical products" which are divided into the following five categories:

(a) scientific and technical information; for this kind of information, the users include R&D staff in pharmaceutical firms and researchers in universities, colleges or other institutions.

(b) business information; the major users for this kind of information are managers in pharmaceutical companies.

(c) drug information; for this kind of information, most requests are from GPs, hospital doctors and other health professionals.

(d) patent information; on one hand, pharmaceutical R&D need patent information for current awareness and retrospective retrieval, on the other hand, for research based pharmaceutical companies an effective patent protection system is vital for their survival.

(e) statutory information; which is requested by government authority from pharmaceutical R&D institutions when they apply for the approval of clinical trial or from pharmaceutical companies when they apply for the approval of marketing a new medicine.

In the following two chapters we attempt to draw a more comprehensive system picture of pharmaceutical information flow in UK (Chapter 7) and China (Chapter 8). Based on the advanced UK information flow infrastructure, a conceptual system model will be drawn in Chapter 9.

The main elements of the UK pharmaceutical information flow infrastructure is shown in a diagrammatic form in **Figure 7.1**.

As has been reviewed in Chapter 1, there are a large number of information studies on pharmaceutical information in UK, since the pharmaceutical information has been of ever

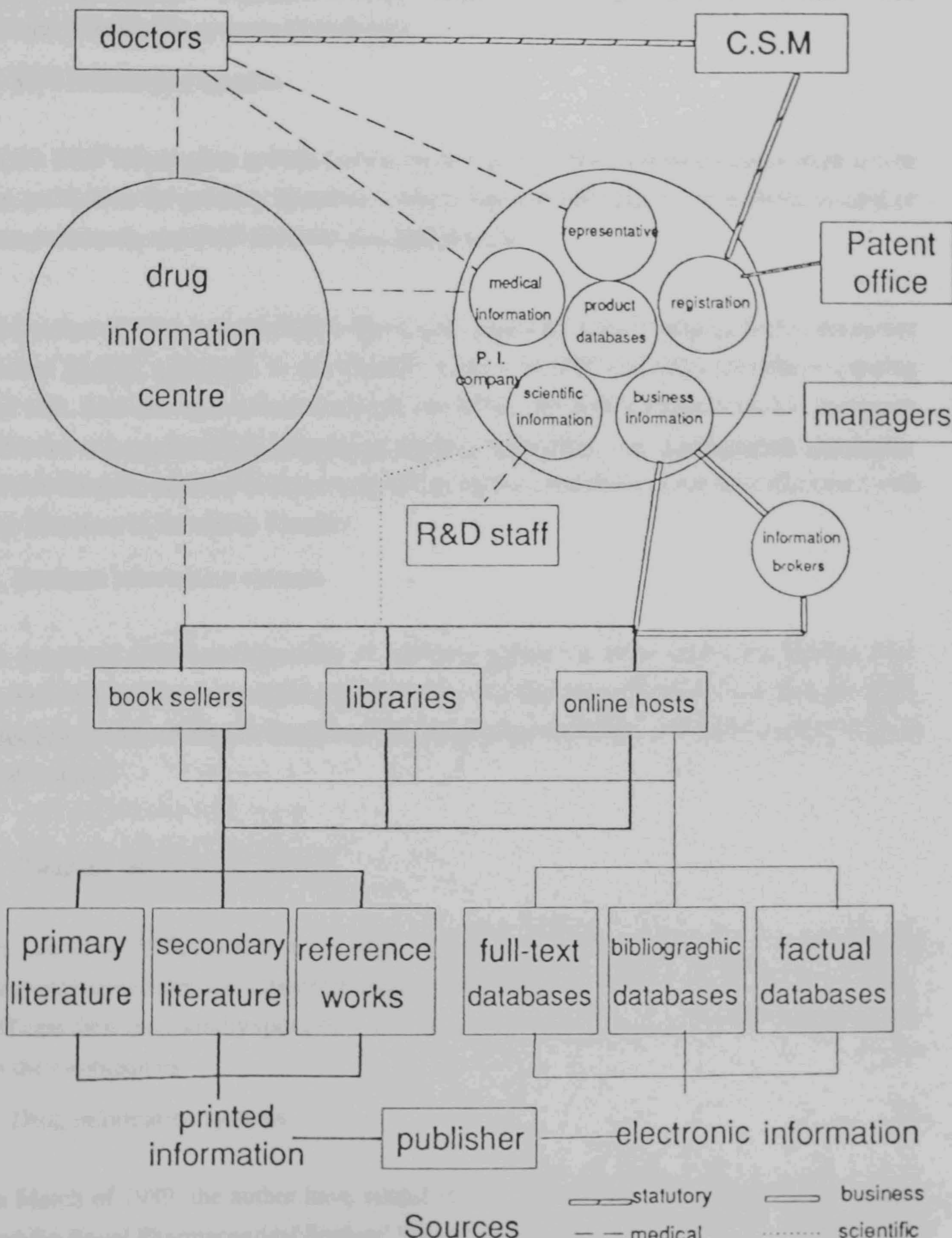


Fig 7.1 Pharmaceutical Information Infrastructure in UK

increasing importance in this country for the last few decades. Many aspects of pharmaceutical information have been studied by experienced information staff in industry, in NHS and in academic institutions. All these have provided this Ph.D study with a very rich knowledge resource. To supplement the existing studies, the author have selected and visited several information systems of each type:

1. S&T information systems

In the S&T information system (as shown in Fig. 7.1), there are three major work forces i.e. *publishers* for primary literature, *abstracting and indexing services* (both printed or computerized), and *S&T libraries and departments*.

In October of 1990, with the S&T information delegation from Academia Sinica, the author visited BLDSC and SRIS. In this Chapter, data on BLDSC and SRIS are collected during the visit. Also during the same academic tour in UK, the author visited three UK university libraries at Loughborough University, the City University, and Southampton University. In this Chapter, data and discussion on UK academic universities have been discussed with the librarians in the above libraries.

2. Business information systems

In August of 1989 and September of 1991, the author has twice visited the leading pharmaceutical information publisher PJB in UK. One American based information company Disclosure and one French based business information company *SVP* have also been visited and studied.

3. Company information systems

In August of 1989, the largest UK pharmaceutical company Glaxo and the another world largest pharmaceutical company Farmitalia's UK branch have been visited. The information officers there have kindly spent their time to describe and demonstrate the information work in their companies.

4. Drug information systems

In March of 1989, the author have visited the library of School of Pharmacy at London, and the Royal Pharmaceutical Society' library and information service. The chief librarian and information officer there have described and demonstrated the information work in their organizations.

5. Patent information systems

In October of 1990, with the Academia Sinica delegation, the author visited the patent information division at SIRS. The patent information work and network in UK have been described and demonstrated by the information officers there.

6. Statutory information system

Finally, the Centre for Medicine Research (CMR), as an unique information and scientific research resource in Europe on some aspects of pharmaceutical industry, was visited by the author in the October, 1991. CMR was established by the ABPI in 1981 as an independent scientific unit to undertake research into the development and safe use of medicines. By working closely with pharmaceutical companies in European countries, USA and Japan, CMR has established several databases, including international database of marketed medicines, UK product databases, control animal pathology database, international toxicology database and general practice database etc. which constitute an unique resource for the international pharmaceutical industry. Its contribution also includes several aspects of medicines research, such as New Chemical Entities (NCEs), patents, R&D expenditure, harmonization of toxicology guide-lines, etc..

7.1 UK Publishers for Primary S&T Literature

In UK, the primary S&T literature is published by commercial publishers and university presses. The UK publishing industry is among the largest publishing industry in the world. Since 1950 when output of titles in the UK was under 20,000, the total rose to over 62,000 by 1988. By the year 2000, it is estimated as likely to reach 90,000 titles (Enright, 1990). There is no clear picture of the total number of learned or scholarly journals in UK. According to the Royal Society survey in 1981 (Royal Society), there are 1500 such journals excluding engineering, clinical medicine and social science. Another estimation puts the number of UK learned or scholarly journals at some 4000 (Vickery, 1987).

Before the World War II, the publication of learned scientific journals was a small and not very profitable business. Since then, however, there has been a massive increase of journal literature. One effect of the information explosion has been the substantial improved profitability of learned scientific journals. Commercial publishers have moved into what had previously been largely the preserve of learned societies, although the large proportion (65%) of UK learned journals is still in the hands of learned societies (Royal Society, 1981).

As a consequence of the improved profitability, for the last twenty or so years, there has been a rapid inflation in journal price in the UK and world-wide which is said to have kept higher than general inflation rate (Royal Society, 1981 & Burrows, 1989).

For example, during the past ten years (1980-1990), there has been a rapid escalation in journal prices, the average increasing by 245%. The UK *university pay and price index,* considered to be conservative and in arrears, gave a value of 235.6 at July 1988 (Nov. 1980 =100) for books, periodicals and binding compared with 160.9 for all other non-pay items (Enright, 1990).

The combination of the proliferation of scientific literature and the inflation of its price has put enormous pressure on library acquisition and collection not only in academic libraries but also in industrial and other kinds of libraries.

7.2 UK Abstracting and Indexing Services

The major abstracts and indexes databases are international in both their coverage and their sales. Several major services are based in UK, for example INSPEC, CAB, and Information Retrieval Limited. Publishers or producers of the UK abstracting and indexing services are commercial firms, learned or professional societies, government bodies and academic institutions.

Using *Inventory of Abstracting and Indexing Services Produced in the UK (BL, 1983, 1986)*, Steptens (1987) presented a brief survey of UK secondary services. He shows that the UK secondary services community is continuing to develop in response to demands from the marketplace, both in terms of producing new services and in increasing the availability of services online. There were **430** UK secondary services available in 1986 which represented an 11% increase since 1983. About 46% of services in 1986 could be accessed online, compared with just 31% in 1983. The number of online bibliographic databases comprising these services almost doubled over the same period- from 50 in 1983 to 93 in 1986. The UK abstracting and indexing services produce about **3 million** bibliographic references annually.

US dominates both the world S&T secondary publication and the world S&T online market (**70% of the world market**) while other major market forces are from Europe and Japan. The share of world online market (S&T section) between US and European is shown in **Table 7.1.**

Table 7.1 West Europe and North American Online Revenues Forecasts 1989-1994 (in **US$ million**) (Fischer, 1990)

year	1989	1990	1991	1992	1993	1994	growth rate p.a.
S&T in Europe	180	205	225	245	275	295	10%
total in Europe	2417	2844	3432	4120	4929	5828	19.2%
S&T in US	423	503	599	712	848	1010	19%
total in US	8587	9675	10916	12335	13962	15829	13%

Table 7.2 General Secondary Sources in Pharmaceutical Areas (data in 1988)

name	year coverage	journal coverage	country coverage	records number per year	issues per year	database	online via hosts
CA (US)	1907-	12,000	100	500,000	weekly	CA	BRS, STN DATASTAR DIALOG, ESA-IRS, ORBIT etc.
IM (US)	1960-	3200	70	250,000	monthly	MEDLINE	DATASTAR DIALOG BRS,NLM etc.
EM Nether-land	1946-	4500	110	250,000	monthly	EMBASE	DATASTAR, DIALOG BRS etc.
BA (US)	1926-	8580	100	262,000	semi-monthly	BIOSIS	DIALOG BRS,SDC etc.
IPA (US)	1964-	700	-	12,000	semi-monthly	IPA	DIALOG BRS, SDC NLM etc.

In pharmaceutical areas, the major large international English language abstracting and indexing services include Chemical Abstracts (**CA**), Index Medicus (**IM**), Excerpta Medical (**EM**), Biological Abstracts (**BA**), International Pharmaceutical Abstracts (**IPA**) and Science Citation Index (**SCI**). The large world secondary publications could cover most of UK scientific literature (Royal Society, 1981). They all are online available via international hosts (**Table 7.2**).

The three major services based in USA - CA, IM and BA use British organizations to abstract and index the British published literature.

7.3 S&T Libraries and Information Departments in Britain

Libraries have a pivotal position in scientific information dissemination and is one of the most important channels for scientific and technical information. Libraries in the UK may be grouped in the following categories:

(a) the British Library, the National Library of Scotland and the National Library of Wales;

(b) public libraries

(c) university, polytechnic and college libraries;

(d) school libraries;

(e) internal libraries of industrial, commercial, and government establishments, and hospital libraries;

(f) libraries of learned societies, and other independent not for profit libraries.

In the UK, the S&T library/information systems have been well organized at national level with a comprehensive and effective back-up documents supply service provided by the national scientific lending library: BLDSC. There are about 400 S&T libraries serving the total 220,000 S&T workers in the country (Royal Society, 1981).

National S&T Libraries

During the 1950s, the UK government decided to set up two major national scientific libraries, one for lending and one for reference. The former is today's BLDSC. The Document Supply Centre (BLDSC) is responsible for supplying a wide range of customers with documents of any kinds. The latter, today's Science Reference and Information Service (SRIS) provides information and reference services to scientific and industrial customers nationwide. Following an internal reorganization of the British Library in 1985, BLDSC and SRIS became the two units of the newly formed Science, Technology and Industry division.

The origins of the SRIS go back to the Patent Office Library founded in 1855. In 1966, the British Museum took over the Patent Office Library to set up a new national S&T reference library NRLSI which changed name as SRIS in 1985.

SRIS is internationally unique, there being no counterpart anywhere to its very large collections. S&T periodicals are acquired from most countries, irrespective of the language, but in general books are taken only if they are written in English, French or German, or in the case of other languages, only if they describe a subject on which the country of origin may be expected to have special knowledge. The only publications held indefinitely in SRIS are patent specifications and abstracting journals.

In 1989/90, it holds 229,000 monographs, 31 million patents and 67,000 serial including 30,000 current periodicals. In 1989/90 its acquisition are 6,882 monographs, 1.1 million patent specifications and 29,484 current serial (BL 17th annual report 1989-90). On this resource, SRIS provides several services including photocopy, industry property, patent information network, business information, computer searching, biotechnology information, Japanese information etc.. During the 1980s, Patent Information Network (PIN) was created in the country. Now it is made up of 7 patent libraries (equipped with patent documents and searching tools) and 12 patent information centres (equipped with patent searching tools only). They are based in local authority reference libraries. SRIS with an annual intake of over one million world patents, provides the documentation itself as well as substantial support to the national network in the areas of training, promotion and marketing (SRIS, 1990)

BLDSC is regarded as one of the world's most comprehensive and effective library systems of its kinds. It is concerned with collecting publications and making them available both within the UK and world-wide. Its special purpose is to supplement the resources of other libraries and it does this by lending and making photocopies from its own stock.

Because of the lack in demands for foreign information, BLDSC has made its acquisition policy as

> "to collect serial literature in all subjects from all over the world and in the vast majority of languages.

"to try to obtain all serious, academic and research level monographic item in the English language wherever published but to be very selective in purchasing foreign language monographs." (BLDSC, 1990)

In 1989/90, BLDSC holds 2.8 million monographs, 211,000 serial including 55,000 current serial, 3 million reports in microfilm, and 510,000 theses. In 1989/90 it has an annual intake of 40,000 monographs, 55,000 serial, 130,000 reports in microfilm, 10,000 theses (BL 17th annual report 1989-90). Based on this resource, every two seconds BLDSC handles another request for documents from any one of more than 12,000 customers world-wide. In 1989/90, it received total of 3,320,321 requests of which 76% from UK and 24% from overseas. Also in 1989/90, its satisfaction rate was as high as 92.3% (87.6% were satisfied from its own stock) (BLDSC, 1990).

Academic Library

There are about sixty universities in UK which play an important role in R&D in the country. The number of R&D staff in universities has slightly grown from 6,300 in 1983 to 8,400 in 1989 (Annual Review on Government Funded R&D, 1990).

The UK university libraries may be divided into three groups

1. Large library with

collection: 1.5-4 million volumes;
periodical subscription: over 10,000 titles;
library staff (full time): around 200;

2. Medium sized library with

collection: 0.5-1 million volumes;
periodical subscription: 5,000-10,000 titles;
library staff (full time): around 100;

3. Small library with

collection: 0.1-0.5 million volumes;
periodical subscription: 1,000- 5,000;
library staff (full time): around 50;

A rough estimate is that there are about 5 in the large library group, 12 in the medium sized library group, and 25 in the small library group[11] (Library Year Book 1985-1987).

As a typical small sized S&T university in UK, the Pilkington Library in Loughborough University has about 80 staff, just under £800,000 budget and around three hundred online searches annually. Its collection of over 500,000 volumes and 4000 current journals serve the university's 800 academic and research staff, 4500 undergraduate students and 1500 postgraduate students.

For the last ten or more years, British academic libraries have faced major financial, technological and organizational challenges. Cut in funding, the spread of IT and changes to the provision of higher education as a whole are combining to alter fundamentally the circumstances in which academic libraries operate.

Line (1990) has recently identified the main current issues in UK academic libraries.

"The main fundamental problem facing academic libraries is their inability to maintain their acquisitions and services at present levels.

"Even in countries that are relatively wealthy, governments are trying to cut public expenditure and since higher education accounts for a significant amount of this, it has received reduced government funding over the last decade or two.

"Since staff account for a high percentage of all recurrent expenditure in academic libraries- in the UK typically about 55%- saving have had to be made here.

"Books and journals have increased in price a good deal faster than general inflation for several years. If a library were to buy the same proportion of output that it acquired 10 or 20 years ago, it would have needed an increase in acquisition funds of something in the order of 15% per annum on average. It is safe to say that no library has received funds of this kind.

"Information Technology is having a big effect on libraries, though to date this has been confined mainly to "housekeeping" automation- of catalogues, issues records, acquisitions and so on."

11 Some university libraries have no full records in the source book.

Resources Sharing and Documents Supply in UK

It is estimated currently there are some 14,000 chemical related S&T journals and some 20,000 biomedical and life science journals in the world (Mullen, 1990 & Duckitt, 1990). No single S&T library but national library could afford to collect such vast amount of journals today.

In 1961, the National Lending Library for Science and Technology was established, a library which has now become BLDSC. The concept for such a national lending centre has been that a large central collection dedicated to document supply can achieve a higher fill rate and faster speed of supply than systems involving cooperation between libraries. The BLDSC own stock could satisfy about 87.6% of all British interlending demand, the remainder 4.7% is satisfied by other library sources with only 7% unsatisfactory. The annual requests to BLDSC has doubled to over 3 million during the period of 1972-1990. Request from academic sector accounts for 40% of total demands in BLDSC while industry accounts for 28% (BL 17th annual report 1989-90).

7.4 Business Information

Business information is a boom industry in UK in the 1980s, partly owing to the "Thatcherism" market economy which is in favour of capitalism and competition, partly owing to the ever improved IT. Since 1988, Headland Press has carried out an annual survey on UK business information industry. Using its publication **Business Information Yearbook** (1988/1989, 1989/1990, 1990/1991), one can get a good outlook over the status and trends of business information industry in UK.

7.4.1 Trends

The trends for the last half of 1980s are summarized as follows:

1. New start-ups

New business start-ups are a continuing trend in an industry like business information. It is the kind of sector in which the cottage industry is an appropriate form, because the strength of any publishing organization is its ideas.

2. Public sector involvement

There is a lot of pressure on public bodies who collect and disseminate business information to realize the wealth that they could create. Thus the Companies Registration Office is seeing its status change to one of government agency, responsible for its own income and expenditure. The British library with its commercially operated business information services, is becoming far more outgoing in marketing its services. A self-financing Business Information Network was created by SRIS in July, 1989. It will take and consolidate information through existing links with public sector libraries. Likewise, many public libraries are considering whether and how to become involved in the provision of business information.

3. New formats

After an explosion of new products in the mid-1980s, most market niches for business online databases in the UK are now more or less filled.

In 1990, CD-ROM made a stronger impact on the UK business information scene. However, CD-ROM appears to have made more headway in the secondary rather than primary information market. There is some debate as to whether CD-ROM with monthly or quarterly updates is a suitable medium for fundamental financial data. Experts' view is that many heavy users of company data will tend to use CD-ROM data as first resort and update it with online access. The trend in CD-ROM business databases development is still not clear.

7.4.2 Sources and Services

1. Business Publishing

Business publishing is growing faster than many other sectors of the UK publishing industry. Apart from the increase in the number of publications, the buoyancy of business publishing is exhibited in the hectic activity in the marketplace, including takeover, alliances and new companies launches.

In past few years, the author visited PJB Publications in Surrey several times. PJB is a UK based pharmaceutical business information company with about 130 staff and annual turnover of over 9 million pound in 1990. PJB publishes a range of international business newsletters, annuals and special reports for senior executives in the pharmaceutical areas world-wide.

PJB currently publishes 5 business newsletters **Scrip, Clinica, Animal Pharm, Agrow, Haznews**; and the annual **Pharmaprojects.**

Scrip - a biweekly journal - covers all types of information concerning world pharmaceutical industry and market such as sales statistics, medical statistics, product information, company information, country information and R&D activities etc.

Updated monthly, *Pharmaprojects* provides business information (R&D, products, marketing etc.) on over 5500 drugs in active research and development in 800 companies and 200 therapeutic fields world-wide.

All business newsletters can also be accessed online via host Data-Star, as part of PHIND- The Pharmaceutical and Health Industry News. **Pharmaprojects** is also available online via Datastar with two files covering current and discontinued drugs.

PJB also produces a wide range of reports relevant to the pharmaceutical industry. Reports are written by in-house specialists with additional material supplied from editorial staff on the business newsletters.

Most important in the supply of market data to the pharmaceutical industry is *International Medical Statistics (IMS)*. IMS international group is an international business publisher and at the same time a database group with operations in more than 60 countries and an annual turnover in excess of $400 million. By 1989, it has got 10 years experience in online services to its users over the world. IMSBASE is one of its major pharmaceutical business databases containing the full text of many IMS hard copy publications and online available via IMS.

Among many regular business publications of IMS, there are *Index of Drug Chemicals, Pharmaceutical Market World Review, Leading International Products Review, Leading International Generics Substances etc.*.

Aiming at providing pharmaceutical industry managers current business information, IMS publishes the well known *Marketletter*, which perform a very similar function to *Scrip*.

Gurnah (1991) has selectively described business information sources available to pharmaceutical industry. He provided a summary of 26 textual databases covering information relevant to marketing and commercial departments in pharmaceutical industry; 13 US based, 10 UK based, other three from Japan, Austria, and Holland. Except IMSBASE and other two online databases which are hosted by the database producers, all others are online available via general hosts such as Dialog, Datastar etc.

2. Company Information

After many years of stagnation, company directories are going through something of renaissance. The major recent developments in company information have been the continuing improvement in the services offered by Companies House (previously Company Registration Office), a new generation of business directories, and link-ups between print and online producers.

By law all limited companies (over 1 million pound) are required to submit audited annual accounts to Companies House. Apart from information services provided by Companies House, many information providers or "brokers" processing and delivery annual reports and accounts of specified companies on request. Other suppliers reproduce financial data in cards, press cutting as well as electronic delivery and floppy discs; ranking within an industry by performance ratios.

Disclosure is an American company who recently opened their first UK branch in London. Specialising in US companies reports, the London office provides management, financial and stockholder information on more than 12,000 companies whose stock is traded on the N.Y. Stock Exchange, National Association of Securities Dealers Automated Quotations system or Over-the-Counter, and London Stock Exchange. It claims to be able to offer a hard copy delivery service within two hours of order (in centre London) and 24 hours elsewhere.

It also runs a service similar to SDI, providing corporate profiles which contain a company resume, major financial and earnings data, complete list of subsidiaries, president's letter, management discussion, and information on officers and directors.

In pharmaceutical areas, PJB commissions studies on individual companies form time to time. Other PJB publications on companies include Scrip's *Pharmaceutical Company League Tables (annually)*. and *the Directory of Pharmaceutical Companies*.

Similarly IMS also regularly publishes information on pharmaceutical companies, such as *Guide to Pharmaceutical Company Sales*, *World Drug Market Manual* etc. These information are also available online in IMSBASE.

3. Market Information

Sales statistics about sales revenue of competitors, market outlets, and products is of immense interest to pharmaceutical managers. Most important sales statistics source is International Medical Statistics (IMS) which collects sales data from either wholesalers or pharmacies in more than 40 countries in the world. For some of the developed counties, the data are virtually census data, covering over 80% of the market there.

All industries need market research surveys to know their customers' opinions. In the pharmaceutical industry, this kind of market research is carried out with doctors to determine patterns of usage, potential markets, new therapy needs and so on.

There are innumerable business consultants or organizations specialising in all subjects who publish a great number of market research reports. Today, the Market Research Society representing the profession in UK has 6500 individual members (MRS Yearbook 1989).

In pharmaceutical field, IMS regularly produce medical surveys in several major countries. It publishes *Medical Indices* , *Medical Market World Review* and other information providing data on major diseases and therapy areas in the world. PJB also conducts a certain number of medical market survey and research each year and publishes reports, monographs and other documents.

Other medical statistics sources include WHO, some countries' official publishers, such as HMSO in the UK etc..

Product information can be obtained from the manufacturers data sheet which accompanies the product. Most major countries publish national datasheets collection. For example, *ABPI Data Sheet Compendium* is published annually by Association of British Pharmaceutical Industry. An international publication on therapeutic agents with references to the market products is *Martindale* - the Extra Pharmacopeia by Pharmaceutical Society of Great Britain. This publication is updated regularly not necessarily annually and is online available via Datastar.

PJB and IMS also provide regular or occasional products information ether in hard copy or in electronic forms.

4. R&D Activities Monitoring

Because the modern pharmaceutical industry is characterized by high R&D investment and high risk, monitoring competitors' R&D activities and trends is one of the major task in business information work.

There are two major publications which provide this information; one by PJB group called *PharmaProjects (monthly)*, the other by IMS called *Drug License Opportunities (weekly)*. Both publications are available online.

5. Online Business Information

Online business databases are revolutionising the use of business information. Headland Press' Online Business Sourcebook (1990) gives the following review of *Changing Landscape:*

"Computer technology has shaken up the traditional structure of published business information. ... Another important and related characteristic of the new electronic system is a shift away from the physical collection of information to an access-based strategy. Instead of investing large amounts on materials and staff costs in buying and organising collections of information, companies and other organisations will rely much more in the future on accessing relevant external information in response to a particular demand."

In the world online market, business information contributes about 90% of the revenue, the remaining revenue is from legal, S&T, news and other information (Fischer, 1990).

A forecast on the growth of world online market divided by US and European is shown in **Table 7.3.**

Table 7.3 West Europe and North American Online Revenues Forecasts 1989-1994 (in **US$ million**)- (Fischer, 1990)

year	1989	1990	1991	1992	1993	1994	growth rate p.a.
business (Euro)	2286	2584	3145	3806	4579	5448	
total (Euro)	2417	2844	3432	4120	4929	5828	19.2%
business (US)	8132	9136	10277	11578	13063	14762	
total (US)	8587	9675	10916	12335	13962	15829	13%

The Headland Press's Online Business Sourcebook (1990) included around **three hundred** major business information databases in the West.

6. Information Services/Brokers

The information broker was defined by Crawford in 1988 as "an individual or organization who on demand seeks to answer questions using all sources available and who is in business for profit".

By 1987 there has been about 150 such brokers in UK. Although most work force in business information is in private domain, there has been a trend for public organizations to move into this area.

Many organizations offer on-demand information services and based on a major in-house information resource, such as Disclosure UK mentioned above. The author visited another one of such "brokers"- SVP UK in London in the spring of 1989.

SVP UK is the UK member of the SVP international network of business information companies. Over 110,000 users in 16 countries ask SVP 8000 business questions every working day. Questions fall into the following categories:

- companies, products, business services;
- marketing, sales promotion, advertising;

- finance, taxation, exchange;
- governments, politics and social affairs;
- the economy and international trade.

SVP UK is associated with IFF Research UK LTD - a major independent industrial marketing research company. IFF has made over to SVP its business information centre, built up over 18 years in research. IFF survey researchers are available to carry out project work for SVP clients. SVP researchers are developing and updating the information centre, and using subscriptions to over 300 databases world-wide to provide inquiry answering.

SVP operates on a subscription basis with each subscription tailor-made for each particular company depending on the type of information required.

7.5 Information Services in Pharmaceutical Companies

The pharmaceutical industry is a high-technology, high-investment and heavily information-based industry. The final output of this effort was the introduction of a small number of chemically new drugs plus a massive volume of data related to the pharmacological and clinical properties of these substances and chemically similar substances that failed to prove safe and effective for the treatment of human disease.

In general, information work in a R&D pharmaceutical company is allocated into the following units: scientific and technical information unit, medical information unit, business information unit, statutory information unit, representative/promotion unit, and internal database system (Fig. 7.1).

Among research based companies, information services may differ from each other, depending on the organization structure and management of a company. However, S&T information unit and medical information unit are most likely to be found in all research based pharmaceutical companies.

A survey on information work in 18 British pharmaceutical companies was carried out (Clark, 1985). It reported all large research based companies have S&T library/information department. All the companies have medical information service, and have internal databases (80% have been computerized by the time of survey). All companies use online for external databases searching. All companies produce internal information bulletins.

In the UK research based pharmaceutical companies, approximately 3% of the R&D work force is in information division. Thus a common level of 100 S&T information staff and 10-20 medical information staff in some major companies is not unusual (Ward, 1990).

7.5.1 S&T Information Work

Key activities seen within most **scientific and technical information** units include:

1. Providing access to all forms of publicly available information: books, journals, patents, standard, government publications, reports, statistics, the media; primary, secondary and tertiary material; print and non-print formats.

2. Management of library stock.

3. The review of published literature to support consideration of possible areas of future research.

4. Searching the world's chemical literature and patents to establish the novelty of a newly synthesized chemical as a potential drug candidate.

5. Informing research staff of current developments and new methodology in their particular speciality.

6. The collection and systematic storage of all data generated on research compounds in a form which assists review of activity and comparison with known drugs and previous research compounds and which also meets legislative requirements.

7. The maintenance of stores of company compounds as a source of samples for examination in new test areas.

8. The monitoring of changes in legislation affecting the industry.

9. The provision of published and unpublished information to the registration department for use in product licensing activities.

The following examples are drawn from the two of the top 7 UK companies: GLAXO and ICI Pharmaceutical Division.

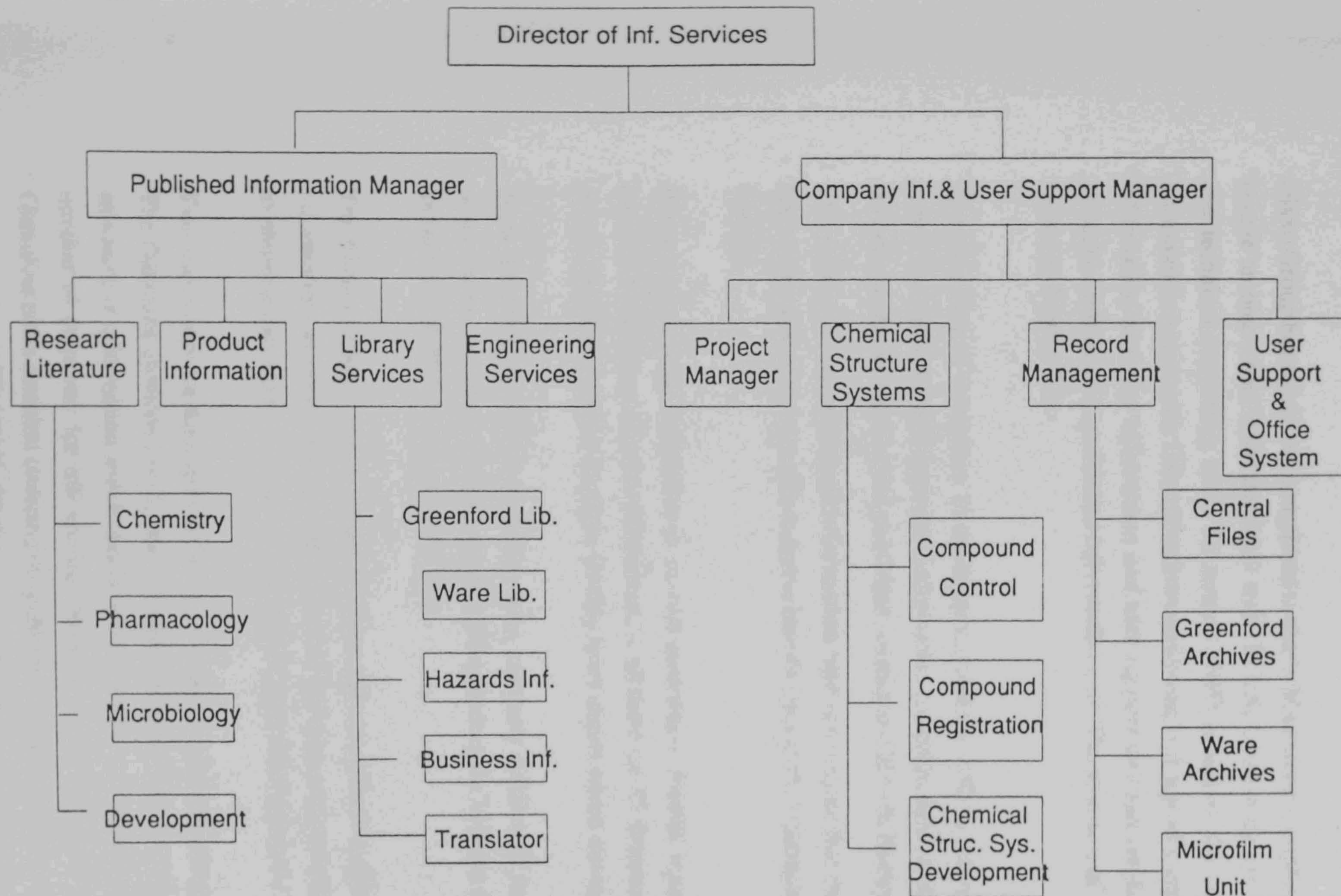


Fig. 7.2 Information System & Services Division in Glaxo Group
(source from Glaxo Research Group Inf. Service, 1989)

GLAXO

Glaxo Group has subsidiary companies in nearly 50 countries, employs about 30,000 people among whom 2500 are R&D staff. In UK, Glaxo employs 1900 scientists and technical supporting staff. To support R&D in Glaxo, the company has an information system with 110 staff and two units- one in charge of internally generated information *company information and user support unit* and another in charge of published information *published information unit*. The structure of organization is shown in **Figure 7.2**.

The allocation of manpower to the main activities is 50% in information services concerned with internally generated information and collections, 30% in information services based on external and published sources and 20% in library services.

The mission of the **published information unit** is to ensure that the employees of Glaxo Group Research are able to derive benefit from all the information in the public domain.

It has made a large investment in *current awareness*. Journal scanning is used to compile bulletins on all areas of interests; in all there are 35 thematic bulletins each month. In addition, there are three weekly news sheets which are accessible online.

Most information retrieval enquiries from company R&D staff are now satisfied using *online searching*. In 1987, about **5,300 searches** via 25 hosts were carried out, an increase of 35% on the previous year.

The *library services* aim to ensure efficient and cost-effective access to published information; to ensure that the library stock is relevant, comprehensive and current; to obtain photocopies and loans using BLDSC and other specialist libraries.

Two major *internal databases* in Glaxo are Glaxo Product Databank and Glaxoline. The Databank contains key factual information about Glaxo's products; providing an source of information which may be used to produce consistent replies to the large number of enquiries for information received by the company world-wide. The Glaxoline is the database covering the published literature (now up to 30,000 papers) on Glaxo drugs. These two databases are accessible online throughout International Packet Switching Network (IPSS) from more than 20 countries by over 200 users in Glaxo companies world-wide.

ICI Pharmaceutical Division (Jackson, 1987)

Around 4000 people are employed in the UK by ICI Pharmaceutical Division and 10,000 world-wide. The information service at the headquarter has a staff of 50. The allocation of information staff is 40% in internally generated information services, 32% in information services based on external and published sources and 20% in library services.

Information services based on external sources include patent information, conference proceeding information, SDI services, in-house bulletins, journal literature information, secondary services, company information on competitors, statistics etc. The percentages of expenditure of ICI pharmaceutical division on the different categories of purchased materials (1985) are: 26% in Online and SDI, 29% in monographs, 3% in BLDSC loans, 38% in Journals, and 4% in Patents.

The ratio of expenditure on patents, journals, BLDSC and monographs have not changed significantly over the last ten to fifteen years, with online searching as an added cost. Nonetheless the online costs are more than justified by the many advantages of it.

Over the recent years, the number of unique serial titles to which ICI pharmaceutical division library has subscribed averages 1,400. Each year the subscription list is reviewed and about 50 titles fall off and 50 new ones come in. In contrast to the trend of steadily cancellation of periodicals in UK academic libraries in 1980s (it was reported that during 1980 - 1986, periodical subscription were predominantly reduced by up to 13% in UK academic libraries (Burrows, 1989)); the ICI example indicates a relatively good financial situation in UK pharmaceutical industry information services.

7.5.2 Medical Information Work

During the R&D process for a new drug, the **medical information** unit takes over the task of amassing, evaluating and disseminating information so that when marketing commences the unit is fully prepared to take responsibility for providing an information service on the product. Internally, it receives inquires from company physicians, sales representatives, registration personnel, etc. Externally, services will be provided to doctors, pharmacists and other health care professionals (**Table 7.4**).

Table 7.4 Medical Information Services in Pharmaceutical Industry
source from (Ward, 1990)

Enabling services	Monitoring published and internal information on company drugs. Maintenance of collections of product information. Development of approved responses to enquiries. Monitoring competitor information.
Internal services	
1.Sales & marketing	Training of sales representatives. Approval of product advertisements, labelling and press releases. Preparation of technical and product monographs.
2. Regulatory affairs	Support for preparation of prescribing information documents, patient guidance. Compilation of bibliographies for product registration.
3.Clinical research	Editing company papers for publication. Preparation of slides for external meetings. Literature reviews to provide background for proposed studies.
4. Drug surveillance	Published literature monitoring for adverse events. Ensuring that external enquiries relating to ADR are formally reported.
External services	Handling enquiries on all aspects of company products and related areas. Product complaints.

In Britain, most companies recognize that the marketing of products with complex pharmacological nature requires a back up service to doctors. A product can only be marketed successfully if its full potential as well as its toxicity and side effects are understood. Most pharmaceutical companies have their medical or drug information divisions based on "products profile". According to the ABPI 1982 survey to its 93 members, 61 British pharmaceutical companies received 13,786 external inquiries in a four week period, an average of **226** inquiries per company per month (Williams, 1984). In 1988, ABPI repeated the survey which indicated the ever increasing importance and activity of medical information services provided by UK companies. In 1988, 63 UK companies received 16,856 inquiries over a four week period. That is an average of **268** inquiries per company per month (Huntingford, 1990).

Generally, the generic companies in ABPI do not handle such inquiries, and small companies do not have formal medical information divisions. In 1982, 44 companies of the 61 respondents (72%) had medical information divisions while the others (28%) dealt with inquiries by other technical or marketing departments. In 1988, 63 companies of 74 respondents (85%) had medical information divisions and other 15% of companies dealt inquiries by other departments.

Apart from general reference books, all the 63 medical information divisions use commercial secondary sources. It should be noted that after the 1982 survey, the industry recognized the growing value of online commercial secondary sources of biomedical information. In 1982, 70% of respondents used computerized commercial secondary sources, whereas by 1988 the figure rose to 87.3%. In 1982, 57% of respondents used manual commercial secondary sources whereas by 1988 the figure fell to 31.7%. The number of databases used by UK companies for medical information services has risen from 13 in 1982 to 19 in 1988.

There has been little change in the overall number of companies using and maintaining inhouse specialist collections- 59 of 61 respondents in 1982 comparing to 63 of 63 respondents in 1988. However, the emphasis between manual and computerized systems has changed considerably- from 24 of 61 companies (39%) using computerized systems in 1982 to 49 of 63 companies (78%) in 1988.

7.5.3 Business Information Work

As an example, we quote the description of business information services in Glaxo Group Research as follows:

"1. To ensure that published information relevant to the business interests of GGR and other Group Companies is identified and disseminated in a timely and cost-effective manner:

> * To monitor the national daily and weekly press, the business press and the popular medical press for news of relevance to Glaxo's interests.
>
> * To disseminate selected items through the PRESSCAN service to senior staff in GGR, Glaxo Pharmaceuticals and Glaxochem.

* To provide defined current awareness services to key individuals by monitoring the media for information and data on specific companies, markets and countries.

2. By using the resources of the World's published information, modern techniques for retrieval, and appropriate skills and judgement for evaluation, to answer inquiries from Glaxo staff concerning markets, companies and countries of importance to the Group." (Material from the visit to Glaxo on August, 1989).

7.5.4 Internal Data Management

1. Internal generated information from each major R&D stage

It is said that for every new drug in the world market, more than 8,000 compounds are studied and discarded. A databank in a large R&D based company normally contains at least as many as 50,000 compounds with all sorts of chemical, pharmacological, toxicologic information generated during the many years of R&D; all sorts of medical information during the many years phase I-III clinical trials; and all sorts of product information during later years of postmarket surveillance (Cuddihy, 1975). It should be pointed out that most research collections in large pharmaceutical companies have several hundred thousand compounds, but the numbers decrease very rapidly at and beyond development stages (Bawden, 1991).

During the drug development stages, information scientists in a company usually have to build a proprietary database system to store every kind of information generated from each stage. These include information on - *preparation, purification and assay of the new chemical substances; early pharmacologic* screening data to select substances that are potentially biologically active; *subsequent more extensive pharmacologic/toxicologic tests to select the most promising compounds for testing in humans*.

This proprietary database system needs to be maintain in a form which assists scientific review of compounds and which meets legislation requirements for patent application, for Clinical Trial Certificate application etc.

During the clinical trial process, the process of collecting and of checking the information requires regular visits to investigators or doctors. A major task begins once these records are received inside the pharmaceutical company, the company must hold the information in a form suitable for interrogation and analysis ready for compiling regulatory submissions, either to extend the investigational licence or to be granted a marker licence.

It must also expect questions later on from regulatory authorities, from health care professional and from internal staff who require ease of access to the information. The information needs extend beyond the individual clinical trials, to all human studies and clinical trials, and to the total world-wide experience with the new medicine.

The information work involved in premarket clinical evaluation phases is massive, because the number of patients involved (2000 and above), the number of items of information obtained on each patient over weeks or months, and the complexity of the information. After marketing, clinical trials continue to provide information to further refine the manner in which the drug is used and also the company must establish a general method of surveillance for collection of physician experience.

2. Types of internal databases

The philosophy of today for most multinational companies lies in the creation of a comprehensive database containing information on efficacy and safety from its sponsored studies and trials performed world-wide.

There are essentially two major types of internal databases - one group serving the R&D activities inside a company which is more internal and less known to outsiders; and another for answering product information enquiries both externally and internally.

Product information include unpublished internal research reports, product licence and ingredient data, correspondence, and drug surveillance reports. It also include published literature on products for example journal papers and other documents.

"It is common to find internal databases which index all papers on company products for later retrieval. In the large international companies such databases are often developed by the parent company and are available online to subsidiaries world-wide." (Ward, 1990) One such database *Glaxoline* has been described above.

Supplementing to *Glaxoline*, there is another product information databases *Glaxo Databank* which contains key factual data about Glaxo products.

From these internal databanks, many sorts of documents for different usage are generated. For example, documents for patent application, for Clinical Trial Certificate application, for Product Licence application, for authorities or professional enquiries etc. It is reported that an NDA (new drug application) in US usually consists of 50,000-100,000 pages of data and information on the potential product (Cuddihy, 1975).

7.6 Drug Information - DI Network in Britain

Drug information here is defined as the information about proscription only medicines. Needs for this kind of information are mainly from hospital doctors, pharmacists and GPs.

(a) Sources of drug information

In Britain, needs of doctors for knowing about new drugs can be met by means of **promotional literature** in prescribing documents and in scholarly or professional journals, posted advertisements and representatives from pharmaceutical companies.

In the UK, the manufacturer must produce a data sheet for every product which it is intending to promote - via advertisement or representative or other activities. The vehicle for these documents is *ABPI Data Sheet Compendium*. These prescribing information documents are legally required to ensure a core unbiased summary of information on the drugs against other more biased information such as company representatives, promotion literature and meetings etc..

It is reported that doctors regard the representative as a significant source of information though less important than medical journals, contact with colleagues and conferences. Representatives still account for the largest proportion of promotional expenditure by the pharmaceutical industry (Ward, 1990).

However, few GPs or hospital doctors would feel confident in promotions of being reliability and lack of bias. They need presentations being given by someone who knows about drug trial design and who has developed considerable expertise in critical assessment of drug research. Every year there are many **seminars, meetings and conferences** sponsored by pharmaceutical companies for clinical pharmacologists to give such convincing presentation about their new drugs.

To meet the information needs on specific drug or medicine in medical practice, doctors can turn their inquiries to the following services: the UK national drug information network which links the regional and area drug information centres based on hospital pharmacy; the medical information service in pharmaceutical industry, the Royal Pharmaceutical Society of Great Britain information service, and other medical libraries.

(b) the UK national DI network

The formal drug information services in the UK were first introduced in 1970 at the London Hospital and Leeds General Infirmary. The latter centre became the first regional centre in 1973. By 1981, 20 regional and 150 area centres have existed in all regions in the Britain and constituted the national drug information network (Davies, 1982 & Smith, 1982). The DHSS is responsible for national planning and for the allocation of resources to these regional health authorities.

As a result of cooperation and co-ordination among the regions, the following have been achieved.

1. Data Base of Literature Abstracts from over 80 drug oriented journals. The database has been computerized in the early 1980s.

2. Specialization in Particular Subject Fields, for example Drugs in Breast Milk is the speciality of West Midlands regional centre.

3. Code of Practice for Drug Information Pharmacists.

4. Production of Speciality Bulletins.

5. Circulation of Information Between Regions.

6. Education and Training. etc. (Calder et al., 1981).

Each year the hospital pharmacists and regional DI centres answer a great number of inquiries from hospital doctors, GPs, and other health professionals.

For example, the South Western regional DI centre handled the total 1049 inquiries in 1980; while the whole region's hospital pharmacists received 1,254 inquiries over a period of two weeks in 1980. Given 52 weeks per year, the whole region's pharmacies handled somewhat 65,000 in a year.

Types of enquiry raised by doctors

Typical questions raised by doctors and other health care professionals include:

1. *Availability* Drug A is discontinued. What alternatives are there?
2. *Identification* What is this drug/tablet/foreign preparation?
3. *Side effects* Which drug has caused a problem? Is this drug safe in pregnancy?
4. *Interactions*
5. *Clinical use, administration, dosage* etc..

Table 7.5 compares the types of inquiries handled by the regional centre with the types of inquiries handled by hospital pharmacies. It can be seen that hospital pharmacies dealt with a much higher proportion of inquiries on administration and dosage, whereas the regional DI centre received more on adverse effects and identification. Some changes in NHS drug information services have been noticed for the past several years. These services are now very largely concerned with comparative costs and approved lists of medicines and do not provide a general drug information service as much as they used to (Bawden, 1991).

Table 7.5 Types of Enquiries and Sources for Enquiries in the South Western region in UK (McNulty, 1984)

	1254 hospital pharmacy queries (100%)	Rank	1049 regional DI centre queries (100%)	Rank
administration /dosage	17.6%	2	11%	4
adverse effects / toxicology	9.2%	5	19%	2
availability /supply	9.8%	4	11%	4
clinical use	25%	1	22%	1
identification	2%	8	7%	5
interaction	4%	7	5%	6
pharmacology	5.2%	6	3%	7
pharmaceutical problem	14.8%	3	15%	3

(c) Drug Information Services in Pharmaceutical Companies

In August 1988, the author visited the medical information unit in Farmiltalia UK in St. Albans. The information requirements of Farmitalia UK reflect the company's structure of a medium size marketing department and field force backed by medical and regulatory departments, the bulk of whose work is dictated by international requirements.

There is one full time information officer whose work is entirely involved in both internal and external enquiries, which makes it impossible for him to provide a full current awareness service for the company. The information unit is largely self contained; however, the head office in Milan provides most of the background information needed by those conducting clinical trials in the UK and provides a regular bibliography of papers pertinent to Farmitalia's products.

Some internal requests come form the representatives concerning Farmitalia's products mainly. Information needs also include specific methodological problems encountered during clinical trials.

As Farmitalia's products are strongly biased towards anticancers, enquiries are mostly from hospital pharmacists; there are a few queries from retail pharmacists too.

The information unit only subscribes the core journals of the therapeutic fields in which the company is involved. About 75 titles are received and scanned. BLDSC is frequently used for the back up of documents supply. Online searching is used only when the information is not easily available elsewhere. Medline and Excerpta Medical are the most frequently used databases. Other used databases include Biosis, Martindale, Cancerline and Sedbase. Generally, the information unit is working on a manual basis.

(d) Drug Information Service in Royal Pharmaceutical Society of Great Britain (RPSGB)

The information service of RPSGB was set up in 1968 in response to an increasing number of inquiries being received from pharmacists about drugs or other matters relating to the profession. Prior to 1968, these inquiries were handled by the scientific publications department, i.e. the staff working on Martindale, the British National Formulary or other publications produced by the Society. The ever increasing number of inquiries necessitated the formation of a separate section to handle drug information requests. Three full time pharmacists answer some 16,000 queries each year. In 1987, 3/4 of the inquiries were from pharmacists in community, hospital and industry. The remainder came from allied professions, government bodies, the public, libraries, the press, industry, and marketing and advertising agencies.

Information to answer the inquiries comes from a variety of sources, including card systems, journals and books. Occasionally online databases are used. There are two card systems - one being subscribed by the Society covers foreign proprietary drugs, and the other is compiled within the department. The latter covers 350,000 references and is continually updated by regular scanning of about 30 pharmaceutical and medical journals. About 10,000 cards are being added to the index system each year.

7.7 Regulatory Requirements and Statutory Information

In US, since 1963, a sponsor wishing to undertake clinical testing of a new drug candidate in US is required to submit to the FDA (Food and Drug Administration) an **IND** (Notice of Claimed Investigational Exemption for a New Drug). The IND describes in detail the chemical, pharmacological, pharmaceutical and toxicologic properties of the compound.

Clinical testing in humans is conventionally divided into four or five phases. During pre-market evaluation (Phase I-III), drugs will be tested among **1-2 thousand patients**.

After Phase III trials are completed, the pharmaceutical company will submit a **New Drug Application (NDA)** to the FDA to gain the approval of the release of the drug into the US market.

Phase IV is effectively a controlled postmarket surveillance which carries out the assessment of the relative risks and relative benefits of drug therapy. Such activity (either in the form of controlled studies or of uncontrolled and spontaneous studies) may require the participation of hundreds of doctors and **thousands patients**.

Such clinical studies (phase I-IV) can take anywhere **between 3 and 5 years**.

"Although specific requirements differ, a well prepared NDA targeted for submission in the US will contain the essential information required by other major countries.

"Western European countries (generally) pattern themselves after the FDA and require objective evidence of safety and efficacy." (Williams, 1987)

The UK **Medicines Act 1968** came into force in 1971. It is complex and lengthy (8 parts and 200 instruments). I. H. Harrison (1986) has given a comprehensive guide to this Medicine Act 1968. This guide covers more than 20 subjects on the controls over the manufacture, packaging, labelling, distribution and promotion; of which the following are more relevant to this study:

1. The administration of the Act

2. The licensing system.

The Administration of the Act

In the Act, the government ministers appoint the Chairman and members of the *Medicines Commission,* set up other expert committees, to date six such have been created namely-

1. British Pharmacopoeia Commission
2. Committee on Safety of Medicines (CSM)
3. Veterinary Products Committee
4. Committee on the Review of Medicines
5. Committee on Dental and Surgical Materials
6. Committee on Radiation from Radio-active Medicinal Products.

The Licensing System

The licensing system is the Chief novel feature of the Act. The system ensures that medicines are of good quality, safe and efficacious and are manufactured and dealt with under optimum conditions. The system also enables batches of products to be traced and withdrawn from sale with minimum of delay should they prove sequentially to be defective. The system utilizes three types of licence and two types of certificate each of which permits a person to engage in certain specified activities, namely- product licences (similar to NDA in US), manufacturer's licences, wholesale dealer's licences, clinical trial certificates (similar to IND in US), and animal test certificates.

The product licence is at the heart of the system. To obtain a product licence the applicant must provide a considerable amount of scientific evidence about the product's chemical, physical and pharmacological properties. The product licence lays down the manufacturing and quality assurance specifications of the product, lists its therapeutic indications and contra-indications, gives details as to its packaging and labelling, method of sale, and the conditions for which it can be advertised and promoted.

Information Work Relating to Licensing Procedure

The whole licensing procedure of a product is costly to the applicant not only in terms of licence fees but also in terms of staff and time involved in producing the necessary paper work. It has been estimated that the drug regulatory requirements in the UK cost the community more than £30 million per year, used 1000 staff in industry and civil service, and delayed for about 2 years the introduction of new drugs onto the market. It has also been stated that a combined application for a clinical trial certificate and product licence typically exceeded **4000 pages**, took **8 months** to prepare and cost **£35,000** at 1979 prices (Harrison, 1986).

With such sophisticated licensing system, preparation of new drug registration documents has been proved to be an intensive information work in a pharmaceutical company. It results in the creation of hundreds of volumes of documents. "The final application is frequently delivered in a trunk." (Brown, 1985).

7.8 Patent Information

I. Patent and pharmaceutical industry

Since the 1960s, most of developed countries have introduced pharmaceutical products patents. The function of a patent is primarily to stimulate inventive activity by preventing a new product from being imitated during a legally sanctioned period of 20 years from the date of application (WHO, 1988).

However, because of the increase in drug development time from 5 years in the 1960s to 12 years currently, there has been an erosion of the effective patent life of British medicines which has been cut from 13 years to 6 years over the past two decades (ABPI Pharm. Fact 1990).

The UK Pharmaceutical Industry is said to be unique in its commitment to and fierce defence of the patent system. The Association of the British Pharmaceutical Industry (ABPI) is well known for defending the patent system. "The main arguments put forward by ABPI are that patents encourage ingenuity and invention, offer the prospect of considerable profit for developing a discovery to the commercial scale, and increase the inducement to invest capital in finding, manufacturing and marketing new products. Finally because patents involve disclosure, new ideas are made available to others and thus competition is encouraged." (Nolan et al, 1980).

For the last few years, the Centre for Medicines Research (CMR) in ABPI has conducted several studies on **the Erosion of Pharmaceutical Patents Life in UK and Europe.**

In the western developed countries, patent systems are particularly well used by the pharmaceutical industry; this is because the patent protects the R&D (including intermediate results and processes) rather than just the final products. For them, R&D is costly to design and products need to be on the market for many years and in many countries in order to be profitable. Details on pharmaceutical patent have been given by T. Eisenschitz (1990).

There is no doubt that pharmaceutical patent generation has been greatly concentrated in the developed countries in the world. The Annual Review of Government Funded R&D (1990) provides a comprehensive survey on world patent situation by using patents granted in US for the period 1963-1988. **Table 7.6** shows that although the number of world patents (granted in US) has fluctuated from 1963 to 1988, the number of pharmaceutical patents has steadily increased by over two times. The same trend is also found in the UK patents (granted in US). More significantly, the growth of UK pharmaceutical patents has been much faster than that of world pharmaceutical patents. During the period of 1963-1988, the UK pharmaceutical patents has increased by over 6 times. Table 7.6 also shows that from 1963 to 1988, the percentage of UK patents as the total patents granted in US has declined from 4.1 to 3.4 whereas the percentage of UK pharmaceutical patents as the total pharmaceutical patents granted in US has grown from 3.6 to 6.4. The figures indicate that the steady growth in UK pharmaceutical R&D activity through the past three decades.

Table 7.6 Patents Granted In US From 1963 To 1988
(Annual Review on Government Funded R&D 1990)

Year	1963-68	1969-73	1974-78	1979-83	1984-88
No. of US patents granted	347852	357801	349257	290967	368570
No. of US patents granted in Drugs/Bioengineering	4034	4965	10062	11497	14742
No. of US patents granted to UK	14147	15553	14529	10849	12478
No. of US patents granted to UK in Drugs/Bioengineering	147	190	687	887	945
% of US patents granted to UK in Drugs/Bioengineering	3.6	3.8	6.8	7.7	6.4
% of US patents granted to UK	4.1	4.3	4.2	3.7	3.4

Different from any other primary literature, patents yield, in addition to technological and scientific information, valuable data about the short- and long- range research interests of the various patent holders, and may help in finding and predicting possible corporate mergers.

II. Patent information practice

There is little doubt that patent information provides an example of good documentation practice. "Not only are the printed documents designed and coded to facilitate rapid searching, including easy identification of the different parts and of bibliographic data, but also the layout has been standardised so that every publisher throughout the world follows a closely similar practice. A universal subject classification is applied to all documents, even by countries that also still use a national scheme. Microform versions of many sets are widely available. Electronic databases of the bibliographic and status details and of the abstracts abound." (Hill, 1985)

In 1978, a new UK Patent Act came into operation. On the same time the European Patent Convention (EPC) and the Patent Co-operation Treaty (PCT) become operational. Each of these gave rise to new publications and the three together created quite a complex network of interacting publication channels. M. W. Hill (1978) has given a detailed description on this issue.

Although it sounds quite complex, patent documents have been well organized by specialistic services.

Firstly, official journals from national patent offices, international organizations (such as EPO) provide regular and timely information on patent application, granting, expiring, and legal issues etc.

Secondly, with the ever-improving IT capacity, serval large secondary publications in the world have been providing comprehensive means for patent retrieval.

It has been estimated that among the 800,000 or so patent documents published each year, there are descriptions of only 300,000 different inventions. Of the 60,000 applications for patents each year in UK, more then 60% are from foreign applicants and it is not unreasonable to expect that virtually all of these are also being applied for in other countries (Hill, 1978).

The complex of patent information may be reflected partly from the existence of Patent Family. The resulting set of equivalent applications or granted patents, one in each country, is known as a patent family. Tables of them, sometimes called equivalences or concordances, are published. Today, microfiche indexes and online databases render the family searching a very quick task requiring little skill.

Chemists tend to make better use of patent compared with other subject specialists. This is due partly to the policy of Chemical Abstracts which integrates patents with other literature. The other reason may be the large amount of patents in Chemistry. Each year over one million patents are filed world-wide, of which 10% are related to chemistry (Mullen, 1990).

In 1988, CA indexed about 80,795 patents of which 53.8 % are from Japan, 6.9 % from US and 10.3% from European Patent Office, 9.3% from Germany, 6.6% from USSR and 0.9% from UK (Jhaveri, 1989).

Apart from CA, Derwent Publications (WPIL file) is generally regarded as a major source of world patents. It covers 360,000 patents from 33 patent offices in the world each year, of which about 160,000 are chemical patents and 14,000 are drug related patents (Mullen, 1990). INPADOC is similarly a multinational database covering 55 countries' patent information.

There are as many as 100 online databases plus a certain number of hard copy primary and secondary publications in the world disseminating patent information. The largest databases include four international ones: Biotech Abstracts via Orbit with 60,000 records; CA-FILE via STN with 7 million records; INPADOC via Orbit with 15 million records from 55 countries (which includes a file for China patents since 1985 called CHINAPATS with 2500 records) and WPIL via Orbit etc. with 4 million records from 31 countries (Mullen, 1990).

Thirdly patent document access in libraries has been improved by the efforts of establishing national networks in some major countries in the 1980s (Hill, 1985). As far as library patent information services are concerned, SRIS has been providing a comprehensive service to UK users which is supplemented by a national patent information network of about twenty local patent libraries (7 libraries holding UK and other countries patent specifications and 12 information centres holding only patent abstracts, abridgments and journals). The largest of the libraries in the network are now given the following by the BL:

EP: "A" specifications, the EPO Bulletin, annual indexes, etc.;

PCT : specifications, PCT Gazette, Index;

US: specifications, Official Gazette, Manual of Classification, Index to patent classification, Patent Status File, Subclass and numeric listings etc.;

INPADOC: numerical database, Patent Applicant Service, Patent Inventor Service, Patent Classification Service, INPADOC Patent Gazette etc.

The Patent Office supplies the major libraries with the following:

GB: "A" specifications, the Official Journal (patents), GB Abstracts issued weekly and cumulated annually, the GB classification, Reports of patent cases etc.

It is reported that the number of readers and remote enquiries for the patent information network (not including SRIS) is about 19,000 per year. At SRIS about one third of the 150,000 readers visits made each year patent enquiries. Additionally, there are 19,000 telephone patent enquiries at SRIS per year (Newton, 1990).

Finally, patent document storage and delivery has been greatly enhanced by the information technologies for the past decades. Microfilm, photocopy, facsimile, online database and CD-ROM are either widely applied or still in experimental stage. SRIS is a traditional source of supply of patent documents. Patent Express- a rapid photocopying and delivery service - is one of the fastest growing of the BL commercial enterprises. Its revenue increased from £0.86 million in 1985/86 to £1.42 million in 1989/90.

7.9 Concluding Notes

The pharmaceutical field is research based and wide ranging scientifically. *"The necessity of retrieving information from external sources has led to increased expenditure by the industry, particularly during the 'information explosion' of recent* years. Coupled with the high costs of generating and managing *information inhouse, this rate of expenditure means that the industry spends very freely on information handling.*

"The pharmaceutical industry was one of the first to benefit and is beginning to learn how to apply IT inhouse with the prospect of further enhancing its performance."

(Pickering, 1990)

In the western capitalist system, R&D of medicine is targeted not only in a scientific sense but also commercially. Therefore, information concerning regional disease profiles, health care systems, market sizes, regulatory constraints, competitor activities, sales statistics and so on are greatly demanded by pharmaceutical companies in the western countries.

To be able to release a new drug onto a market, the pharmaceutical company has to meet all requirements of the drug control authorities. The application procedure of clinical trial certificate and product licence usually turns out hundreds and thousands of volumes of documentation. To market a product successfully, a company also need to provide doctors, pharmacists and other health care professionals with sufficient product information. Apart from product information for promotional purpose; the company has the responsibility to answer any inquiries on its products from health care professionals. To do this, most of pharmaceutical companies have a medical information division with professional staff and facilities to access internal and external databases.

To provide drug information to doctors and GPs in a less biased manner, there is a hospital pharmacy based national DI network existing in the UK with some 20 regional centres and 150 area centres. This network is under the central planing of DHSS and deals with immense of inquiries every year in a co-ordinated way. Further more, there are other organizations such as RPSGB which also provide drug information to drug prescribers and the public.

Chapter 8 Pharmaceutical Information Flow Infrastructure in China

In this chapter, the pharmaceutical information flow infrastructure in China is described in **Figure 8.1**. In fact, "pharmaceutical information" is not commonly recognized in China as having the five elements normally associated with it in the West. Today's information flow infrastructure in China is dominated by scientific information systems, other information flows such as business information, drug information, patent information and statutory information are still emerging.

Unlike the situation in UK, there are few studies on pharmaceutical information in China. Most of information studies are generally about S&T information.

Sources of data collected and used in this chapter are given as follows:

1. Data on S&T information systems

During the Autumn of 1989, with the help of S&T information Institute at SPAC, the author conducted a survey on S&T information service within SPAC system. About 25 of the total 35 S&T information services have responded to the survey (Appendix 5.4 giving a sample of the questionnaire).

Furthermore, the following S&T information organizations and libraries have been visited for data collection: the National Library, Shanghai Library of Academia Sinica, Beijing Library of Academia Sinica, ISTIC, S&T Information Institute of Chinese Academy of Medical Science, and Academy of Military Medical Sciences.

2. Data on business information systems

During the Autumn of 1989, the author conducted a survey on business information service for China's pharmaceutical industry. Fifty questionnaire were sent out to the large factories in the Chinese pharmaceutical industry with 30 responses (Appendix 5.5 giving a sample of the questionnaire). Additionally, the author visited six large factories in Beijing and Shanghai. Interviews were given to information officers or production managers.

3. Data on drug information systems

For collection of data on drug information, two group of questionnaire have been designed. One questionnaire was sent to 100 doctors and another to 100 hospital pharmacists with the help of the Research Institute of Clinical Pharmacology at Beijing Medicine University (Appendix 5.1 and 5.2 giving a sample of the questionnaire).

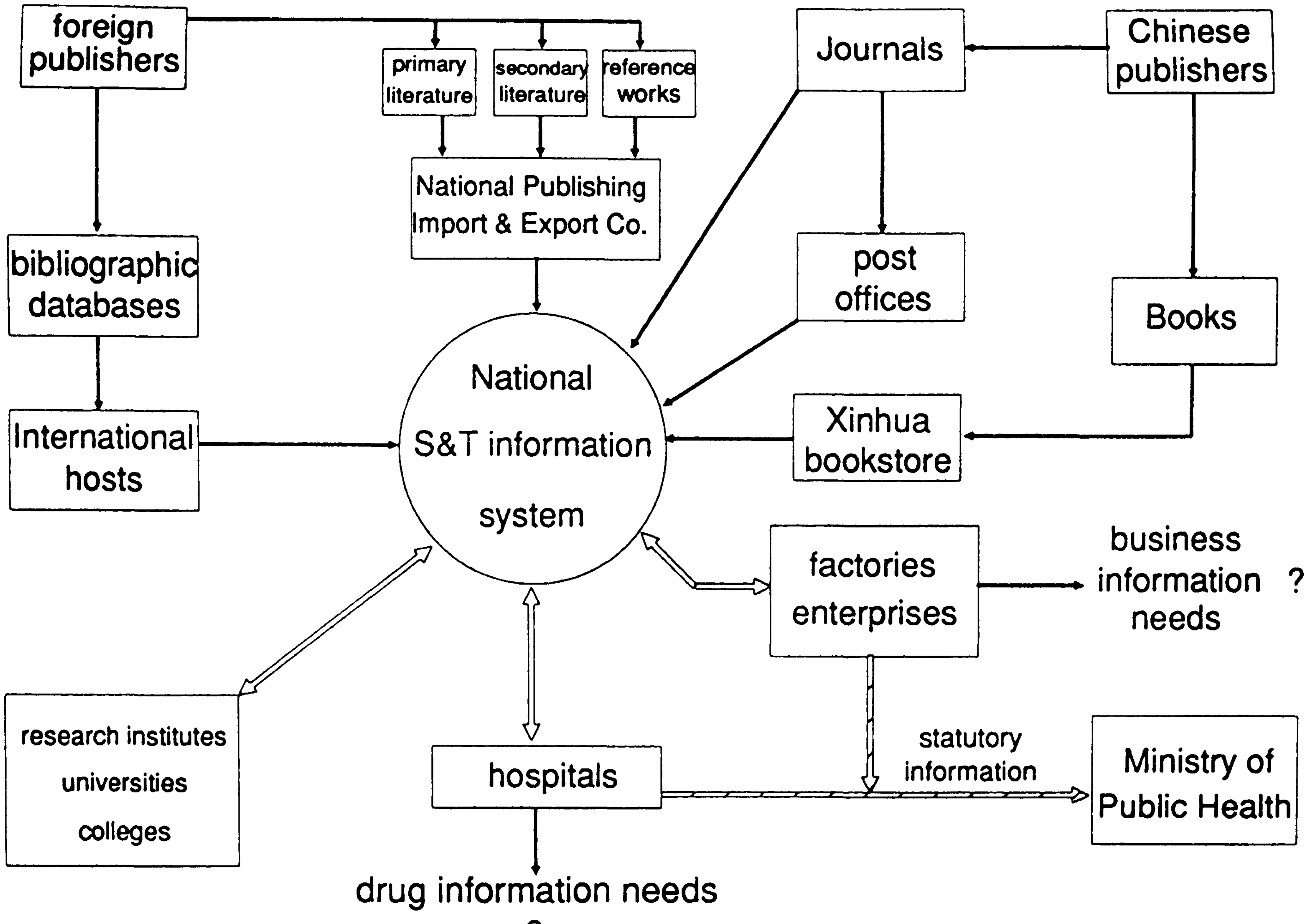


Fig 8.1 Pharmaceutical Information Infrastructure in China

4. Data on statutory information systems

During the Autumn of 1989, the author visited the following government departments: Bureau of Drug Policy Administration at MPH; SPAC, SATCM and the Research Institute of Clinical Pharmacology, at Beijing Medicine University. Interviews were given to the officers there for data collection on statutory information situation in China.

This chapter illustrates the less developed Chinese pharmaceutical information flow. Next chapter will compare it with the advanced UK pharmaceutical information flow.

8.1 Scientific Information Flow

The national science and technology in China is under the direct control of the government. The administrative set up has been given in **Figure 3.4**; in Chapter 3.

Because the emphasis on academic R&D rather than industrial R&D in China, the Chinese national scientific information system (**Figure 8.2**) is dominated by research libraries and S&T information institutes affiliated to their parent institutions.

8.1.1 The Structure of Chinese National S&T Information System

The National Library of China

In 1912 the National Library of China was founded on the previous Metropolitan Library of Peking (Beijing). In 1987 it held about 6.5 million volumes of book, 6 million volumes of periodicals (9,148 titles of current Chinese periodicals, 13,693 titles of current foreign periodicals), 90 thousand volumes of newspaper in about six hundred current titles plus 1.3 million volumes of other materials.

In 1989, NL had an acquisition expenditure of ¥16.6 million. Its acquisition of 7741 world journals accounted for one seventh of the BLDSC annual intake.

The administration is divided into 16 main units, with 1,700 staff members, of whom about 1,200 are qualified librarians or specialists. It has exchanged agreements with over 1,600 libraries or organizations in 100 countries.

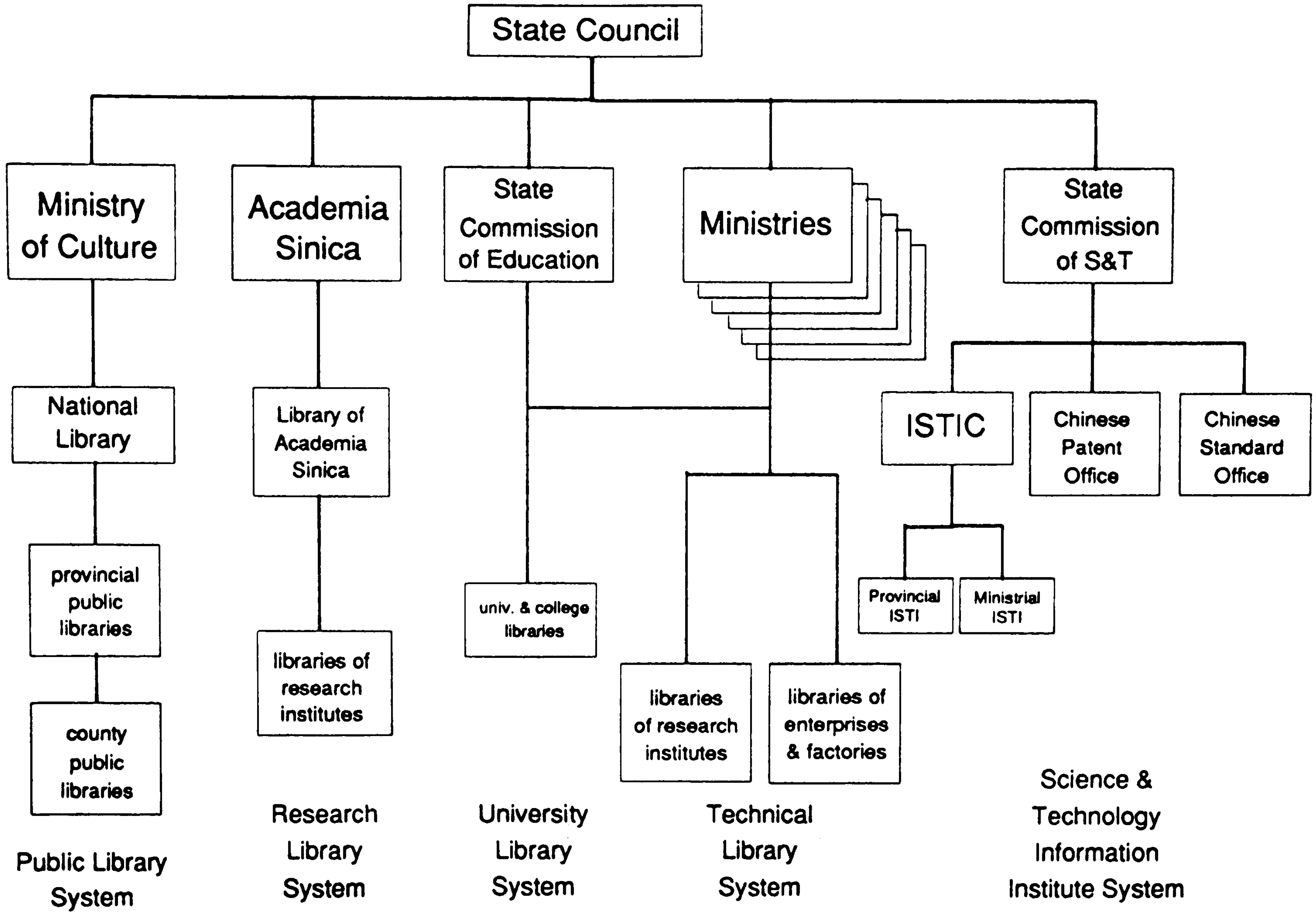


Fig 8.2 National S&T Information System in China

It receives about five thousand readers each day or 1.5 million per year which is ten times the figure of SRIS. Mainly serving and lending to government officials, senior scholars (those with job grade I or grade II, seeing Chapter 3) and some special categories of foreigners. The National Library also admits college students and general workers for reference and reading. The National Library mainly provides reference library service to its readers but is unable to provide a similar documents supply service as BLDSC.

The National Library is the head organization in the national public library network. In practice, those regional and local public libraries are self-governing at the various level of local authorities: provinces, counties, cities and township (formerly called communes). There are 28 provincial public libraries, including the two municipalities Shanghai and Tianjing. They act as the central public library for the provincial capital city, and most provide a variety of services for particular groups, including factories, scientific research institutes and local specialists. Apart from the National Library in Beijing, Shanghai Library is the second largest public library with an acquisition budget of ¥5.7 million in 1989 and an annual intake of more than 4000 foreign journals (National Library of China Booklet, 1989 & Academia Sinica, 1991).

Research Libraries

It was reported that by the end of 1988 there are 5275 government scientific research and development institutions (excluding those in social science, education and defence sectors, and in factories) at above county level, and one million S&T staff, of whom one third have job grade I - III. Within each of these R&D institutions there is usually a library or a information institute (division), or sometime both (White Paper, 1990). There are about 50 national or ministerial S&T information centres plus 350 provincial and regional information centres. Those S&T information establishments serve the information need of the one million S&T workers in the government R&D sector (not including universities and industry).

Generally, the S&T library/information systems have been well organized at the national level and ministerial level in China, although there are problems in resources sharing which are to be discussed in next sections. Under the State of S&T Commission, there is a national S&T information policy making body which

1. Plans for and manages with the nationwide information sharing;

2. Plans for and manages with the national abstracting and indexing services;

3. Plans for and manages with the national computerized S&T databases.

At every ministry, there is a similar S&T information decision making body to advise on the above three issues to the ministerial leaders and to implement the plans within the ministry.

The University and College Libraries

In China, there are 800 S&T universities and colleges (including 130 medical universities with pharmaceutical department/faculty) today. Of them 10% are at the first class - the government defined "important university"; 54% are at the second class - the government defined "general university"; and 36% are at the third class which are similar to the polytechnics in UK. There are total 80,000 academic staff in the 800 universities. Every university has a large central library with departmental libraries around the campus, serving the information needs of teaching and research.

The S&T activities in universities are greatly teaching oriented. R&D is not a major function of Chinese universities.

It is estimated that R&D in Chinese universities account for somewhat twenty percent of the national R&D in terms of manpower and annual expenditure (White Paper, 1990). However, the R&D activities in the universities are less organized by the central government than that in government R&D sector. The S&T information/library work are also with less central plan and management at national and ministerial level than that in the government R&D sector.

The Technical Libraries and Information Services *in Industry*

In addition to the research libraries, there is another group called *technical libraries and information services* in industry, aimed specially at providing information services in support of industrial production.

There are over 10,000 large and medium factories with over 1.6 million S&T staff in China. In pharmaceutical industry, there are 236 large and medium factories with over 30,000 S&T workers (White Paper, 1990).

The major work for industrial S&T workers are manufacturing oriented rather than R&D activities. It is estimated that R&D in Chinese industry account for somewhat twenty percent of the national R&D in terms of manpower and annual expenditure (White Paper, 1990).

Large and medium factories normally have their own R&D divisions and technical libraries or information services. However, the R&D activities and the S&T information in the industry are less organized by the central government than that in government R&D sector.

Furthermore at every level of administration, there are S&T information services. For example within the SPAC administrative system, there is a central S&T information service with 100 staff in Beijing, 9 first grade S&T information services in five big cities, and 25 second grade S&T information services in provinces. These pharmaceutical information services vary in size (from one staff to 57 staff) as well as in organization structure. Figure 8.3 shows the organization of S&T information service at Shanghai Institute of Pharmaceutical Industry which is the second biggest one within SPAC administrative system.

S&T Information Institute System

Apart from libraries, there is another sort of organizations aims at providing S&T information - *institutes of S&T information.* The Institute of S&T Information of China (1958-) is well known as ISTIC. in the world. As a S&T document retrieval and supply organization, ISTIC has two national centres - Beijing centre and Chongqing centre.

By 1987, the Beijing centre holds a collection of 5 million items (including scholarly journals in banded copy, reports, grey literature and microfilms etc.). About 65% of the collection are in English. Its annual acquisition expenditure was ¥ 4 million in 1989. Its annual intake of journal is about 4000 titles in foreign language plus four thousand titles in Chinese. Its annual world journal intake is about 10% of the BLDSC.

The Chongqing centre holds a collection of about 7 million items (scholarly journals in banded copy, patents, reports, grey literature and microfilms etc.). Its annual acquisition expenditure was about ¥2 million in 1989. In 1990 it subscribes to about 2,000 titles of foreign S&T journals and four thousand titles of Chinese journals.

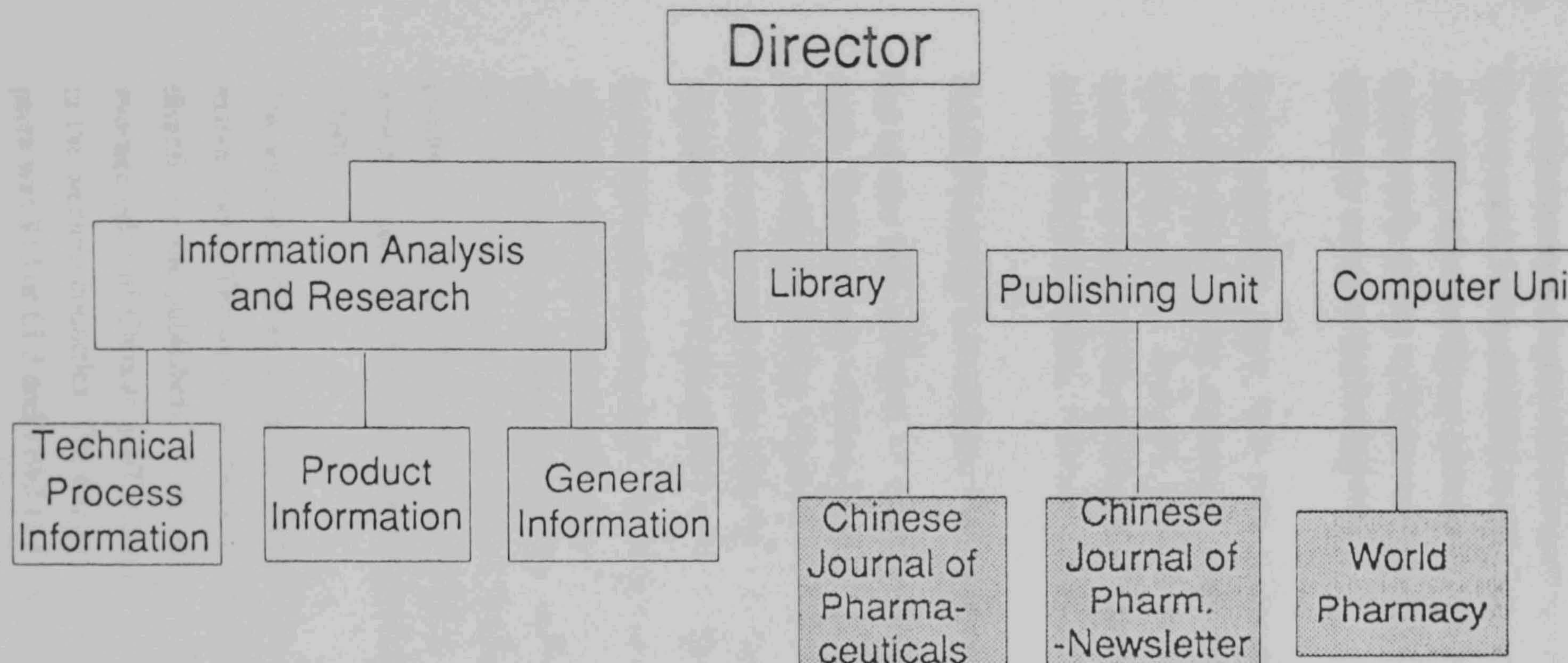


Fig 8.3 S&T Info. System of Shanghai Institute of Pharmaceutical Industry

The staff in the Beijing centre totals over 1,200, and there are another 600 in the Chongqing branch. The Beijing headquarter receives about 100,000 readers from all over the country each year which is much less than the numbers of readers in National Library and 2/3 of that in SRIS in UK. Although it has claimed to serve as a national scientific reference library (non-book), ISTIC is unable to provide a similar documents supply service to Chinese users as BLDSC part owing to the limited collection and partly owing to the limited funds.

Some provinces have their own information institutes. Those institutes are self-governing, taking supervision from ISTIC. Apart from ISTIC Beijing and Chongqing centres, Shanghai Institute of S&T Information is the third largest information centre with an intake of 3000 foreign journals and 2400 Chinese journals in 1989 (ISTIC Booklet, 1989 and Zhou, 1991)

8.1.2 Primary Literature - Resource Share and Document Supply

Let us now look at Figure 8.1 Pharmaceutical Information Infrastructure in China again. There are two information inflow channels - one for domestic information and the other for foreign information. The shortage of hard currency has made the Chinese government to introduce two information input channels parallel to the two currency systems in the country (seeing Chapter 2).

In the domestic market, each year China publish several thousands titles of serial and several ten thousands titles of books. The national S&T literature production is quite big in terms of both the quantity and the proportion in the world production. In 1985, it published 45,603 titles of books which accounted for 2/3 of the UK production (Infor China, 1989). In 1988, it published about 3,000 S&T journals which accounts for 3-5% of the world production and 3/4 of the UK figure. (Zhong, 1990)

The state-run Xihua Bookstore network has a monopoly of the national market of native books. The native journals are distributed either through state post office or directly by the publishers. In the market, the common currency is RMB (¥). The average price of Chinese S&T literature is relatively low compared with the price in the western countries. The average Chinese S&T book price and annual journal price was ¥13 or £1.3 and ¥16.5 or £1.65 in 1990 (Tao, 1991). In 1986, the average UK academic book price was £14 and the annual UK journal price was £60 (Fletcher, 1987). As it has been estimated in Chapter 3, a Chinese employee's annual wage can buy 161 Chinese S&T books or subscribe 127 Chinese S&T journals, while a

British employee's annual wage can buy 723 British or American academic books or subscribe 134 British or American academic journals. Therefore, the major problem of primary literature resource in China is the very limited capacity in foreign literature importation due to the shortage of hard currency.

The China National Publishing Import and Export Corporation (CNPIEC) is the main body dealing with the international book and journal market, in which only hard currency is valid. Because of the inability of gaining sufficient hard currency, the Chinese government has to take a over-all control of the book and journal import and the allocation of hard currency to all departments which need foreign S&T information/documentation. That has meant the scarcity rather than over-abundance of choice in amount and in variety of foreign books and journals for Chinese libraries.

The acquisition policy in the national S&T information system in China is

> "to try to collect domestic S&T information as comprehensive as possible while at the mean time to collect the most important foreign language information under a very selective guide-line.
>
> "The proportion of expenditure in foreign language information to the whole information purchasing expenditure was 64.8% in ISTIC, 51.5% in university library system, 63.6% in Chinese Academy of Social Science and 90% in Chinese Academy of Science in 1988." (Academia Sinica, 1991).

According to the acquisition statistical data from Academia Sinica (1991), in 1989 the average Chinese journal price was ¥15 per year while the average foreign journal price was ¥1500 (data from its annual intake of several thousands of Chinese journals and several thousands of foreign journals) (seeing Chapter 3). Because of the big price difference between Chinese and foreign S&T literature in China, although each year Chinese S&T information systems spend up to 90% of acquisition expenditure in foreign information, their ability in purchasing foreign information is in fact very limited.

Each year, CNPIEC imports some 70,000 titles of foreign academic books and 16,000-19,000 titles of foreign S&T journals (ISTIC, 1986 & CNPICE, 1988). The Chinese national annual intake of world books is **1.75** times the BLDSC while the Chinese national annual intake of world S&T journals is **one third** of the BLDSC. The imported foreign S&T literature scatter over the vast country. There are about ten national S&T libraries each having a collection of more than 3,000 current foreign journals. Furthermore, none of the national S&T information systems including National Library, provide national documents supply service formally.

In China, more than half of the imported S&T literature is concentrated in Beijing. Most of the remaining imported S&T literature is held in Shanghai, Chongqing, Shenyang, Wuhan, Guangzhou, Chengdu and Sian (ISTIC, 1986).

To study the resource share and documents supply of foreign S&T information in Chinese medical and pharmaceutical area, we use three surveys - one is based on the data from China Medical Academic institution Union Catalogue of Foreign Journals (1987), the second survey is based on the statistic data (1989) of SPAC information services, and the third one is based on the survey on information resources in Academia Sinica (Academia Sinica, 1991).

The *China Medical University and Academic Institution Union Catalogue of Foreign Journals (1987)* includes 77 Chinese medical universities (of total 130) and 5 the highest medical academic research institutions (of several hundreds in the countries). Although it is by no means comprehensive in covering all academic institutions in China's medical and pharmaceutical area, the Union Catalogue is the only one readily available for the brief outlook on foreign medical information resource share and distribution in China.

There are about 20,000 current journals in biomedical and life science in the world (Ward, 1990).

Despite the shortage of hard currency, China has tried its best to import most major medical journals in the world, especially from the western world. In 1987, it imported 3391 medical journals, of them 2685 in English (including fewer in other western languages), 466 in Japanese and 200 in Russian. Having compared with Index Medicus (3200 journal coverage) and Excepta Medical (4500 journal coverage), one expert estimated that only some 300 major foreign journals are not imported by China (Xun, 1988).

Of the three thousand imported journals, most have very small number of subscribers in China, because of the limited purchasing ability. It was estimated 31% of imported journals have only one Chinese subscriber each, 32% journals have only two Chinese subscribers each, for 17% journals each has subscribers ranging from 6 to 21, and only 20% imported journals have more than 25 subscribers in China.

There is no question that most of imported journals are concentrated in a handful of big cities such as Beijing and Shanghai.

Among the 82 institutions, the annual subscription of foreign journals ranges from less then ten to 1479 titles. The average subscription was **162** titles each institution in 1987. The number one with the highest subscription was Chinese Academy of Medical Science with an intake of 1479 titles. Shanghai Library of Academia Sinica ranked at the second with an intake of nearly 900 titles. Of the 82 institutions, there are three each with intake of more than 800 titles, 4 institutions each with intake of more than 500 titles. There are 16 institutions (**20%** of total) each having an intake of under 500 titles and more than 162 titles (mean figure). More than **70%** of institutions each has an intake of less than 162 titles.

The State Administration of Pharmaceutical Industry (SPAC) has a ministerial information network, with the headquarter information service centre in Beijing; 9 first grade national information services in 5 big cities (4 in Shanghai, 2 in Guangzhou, other 3 in Tianjin, Chengdu, and Shenyan); and 25 provincial information services affiliated to SPAC provincial branches. The information network mainly provides S&T information to R&D staff in factories where factory technical libraries are in relatively poor condition compared with research or university libraries.

The S&T information service in SPAC headquarter in Beijing has **100** library and information staff and annual intake of **several hundreds** of Chinese and foreign journals.

In 1989, SPAC conducted a survey on the 9 first grade and 25 second grade information services in its network. There were 8 and 17 responses from the two groups respectively.

The eight of the first grade services have total annual information expenditure (including all sorts of expenditure such as information purchasing, salary, equipment, administration etc.) of ¥1,350,000. The top one has annual expenditure of ¥550,000 and bottom one has ¥25,000. The average figure is ¥170,000 per service. There are 145 information staff in the 8 services with an average of 18 staff per service.

The 17 of the second grade services have total annual information expenditure of ¥438,000. The biggest one has an expenditure of ¥80,000 and the smallest has ¥4,000. The average figure is ¥26,000 per service. There are 120 information staff in the 17 services with an average of 7 staff per service.

The survey shows that 75% of SPAC information network expenditure is concentrated in 8 first grade services in 4 cities whereas 17 provincial information services have accounted for only 25% of total information expenditure. The biggest information service has an annual expenditure of ¥550,000 which is 140 times the smallest one with annual expenditure of ¥4,000.

The data on the collection and acquisition of the 9 first grade and 25 second grade information services are not complete and therefore not comparable. The rough estimate is that only 4-5 first grade services each has an annual intake of several hundreds of Chinese journals and several hundreds of foreign journals; while other 30 information services each has less than 100 titles of foreign journals. The 15 smallest ones each only has around 10 titles of foreign journals annual intake.

There are some 236 large pharmaceutical factories with R&D units or divisions in China. Normally there is a technical library or information unit affiliated to each R&D division. In October 1989, the author visited six of the biggest factories in Beijing and Shanghai (all among the top 30 in China). The impression is that the collections and the services in factories are generally very limited. The six factories have employed from 500 - 3000 people; have R&D laboratory ranging from 10 to 200 R&D staff; and have information service or technical library of annual intake of foreign journals raging from 2 to 50. The number of information staff is between 3 and 20.

Generally, the S&T libraries or information services in research institutes and universities are much stronger than that in the factories and that in the administrative departments, because the great concentration on R&D in government research institutes and academic institutions.

For example, Shanghai Institute of Pharmaceutical Industry and Tianjin Institute of Pharmaceutical Industry are the two largest R&D establishments in SPAC. The former has about 1000 S&T workers, 60 information staff, a collection of over 60,000 volumes and 610 current foreign journals and 150 current Chinese journals. The latter has about 600 S&T workers, 40 information staff, a collection of 80,000 volumes and 500 current foreign journals and 1,000 current Chinese journals.

To meet the information needs of the 35,000 S&T workers in Chinese pharmaceutical field there is a 4 level national S&T information network:

FIRST LEVEL - annual acquisition budget over ¥ 4 million, over 3000 current foreign journals and all 3,000 current Chinese journals

1. The National Library in Beijing with annual acquisition budget of ¥16,550,000 in 1989 and an annual intake of about 10,000 titles of foreign journals;

2. ISTIC (Beijing) with annual acquisition budget of ¥4,000,000 in 1989 and an annual intake of about 4,000 titles of foreign journals;

3. Beijing Library of Academia Sinica with annual acquisition budget of ¥ 4,000,000 in 1989 and an annual intake of more than 3,000 titles of foreign journals.

4. Shanghai Library with annual acquisition budget of ¥5.7 million in 1989 and an annual intake of more than 4000 foreign journals.

5. Shanghai Institute of S&T Information with annual intake of more than 3000 foreign journals in 1989.

SECOND LEVEL - annual acquisition budget between ¥0.5-4 million, 500-3000 current foreign journals and a similar number of current Chinese journals

1. Chinese Academy of Medical Science with an annual intake of just under 1500 titles of foreign journals in 1987;

2. Shanghai Library of Academia Sinica with annual acquisition budget of over one million ¥ in 1989 and an annual intake of nearly 900 titles of foreign journals;

3. Shanghai S&T Information Centre of Pharmaceutical Industry (the biggest library in SPAC information network) with annual acquisition expenditure of ¥400,000 in 1989 and annual intake of more than 600 titles of foreign journals;

4. ISTIC Chongqing centre with annual acquisition budget of over ¥2 million in 1989 and annual intake of about 2000 titles of foreign journals;

5. About 15% of universities and government research institutes are estimated in this level (China Medical University and Academic Institution Union Catalogue of Foreign Journals, 1987 & Academia Sinica, 1991)

THIRD LEVEL - annual acquisition budget of ¥50,000-400,000 and 50-500 current foreign journals and a similar number of current Chinese journals
It is estimated about 25% of universities and research institutes in this level (China Medical University and Academic Institution Union Catalogue of Foreign Journals, 1987 & Academia Sinica, 1991).

FOURTH LEVEL - annual acquisition budget of ¥1,000 - 50,000 and less than 50 titles of current foreign journals and a few hundred current Chinese journals

It is estimated that about 60% of research and university libraries and 80% of SPAC information services and 90% of factory R&D divisions are in this level (China Medical University and Academic Institution Union Catalogue of Foreign Journals, 1987 & SPAC Statistics 1989 & Academia Sinica, 1991).

Table 8.1a Annual Change in Foreign Journal Subscription in Library of Academia Sinica (Academia Sinica, 1991)

year	annual spending thousand¥	annual growth %	no. of journals	annual decrease %	average price per journal ¥	annual inflatio%bn %
1985	1880		5196		361.8	
1986	2300	22.3	4766	9	482.6	33.4
1987	3000	30.4	4273	11.5	702.1	45.5
1988	3580	19.3	3318	28.8	1078.9	53.7
1989	3270	-9	2108	57.4	1551.2	43.8

Since 1987, there has been a serious constraint in S&T information budget in China, because of the journal price inflation in the domestic and world market. **Table 8.1a** gives the annual change in foreign journal subscription in the Library of Academia Sinica. From 1985 to 1989, although annual foreign journal expenditure has grown at an average rate of 16% p.a., the number of annual intake of foreign journals has decreased at a faster rate of 27% p.a.. The foreign journal price inflation rate is 44% p.a.(Academia Sinica, 1991). Similar cut in foreign journal subscription has been found in other national S&T information centres (**Table 8.1b**).

Table 8.1b Change in Foreign Journal Subscription
in National Library (NL), ISTIC Beijing and ISTIC Chongqing

year	1987	1990	Change
NL	13693	7741	-50%
ISTIC Beijing	5408	4200	-20%
ISTIC Chongqing	7000	1348	-80%

8.1.3 China Abstracting and Indexing Services

ISTIC has been very much involved with secondary literature publishing since 1961, when the China Commission for Editing, Translating and Publishing S&T Documents (CCETP) was established within ISTIC.

In 1980, CCETP issued "The Plan for the National S&T Secondary Publication System". By 1987, under its supervision, the build up of the national secondary publication system has been completed with 229 abstracting and indexing serial (158 reporting foreign information and 71 reporting domestic information) and an annual production of 1,470,000 records (1,170,000 foreign records and 300,000 Chinese records) in all S&T subjects. However, because of the reduce in funds since 1987, for the last three years there has been a decline in the titles of secondary serial and in the annual production of records. The change of the national secondary system annual production is given in **Table 8.2**.

Table 8.2 The Annual Production of the Chinese National S&T Secondary Publication System (1981-1990)

year	81	82	83	84	85	86	87	88	89	90
serials	134	147	159	195	219	224	229	169	157	156
Chinese serials			101	109	161	160	158			
foreign serials			58	86	58	64	71			
records (000s)	850	900	950	1020	1410	1420	1470	1100	1010	1000
Chinese records (000s)			760	800	1170	1170	1170			
foreign records (000s)			190	220	240	250	300			

From 1981 to 1987, the trends of the Chinese secondary publication include:

1. The increase in secondary publication in titles (increasing by 70%) and in records (by 70%);

2. The introduce of Chinese secondary publications published in English, since 1985; (By 1990 there are 7 titles of such abstracting journals aiming at disseminating Chinese S&T information to the world.)

3. The speed up of producing and publishing procedure; (By 1989, the majority of the secondary publication were published quarterly; while by 1990 the majority has been switched to bimonthly, with 24% monthly, 52% bimonthly and 24% quarterly.)

4. The centralisation of secondary publication; (Since 1980, all Chinese secondary publications have been concentrated in about 20 ministerial S&T information institutes or libraries.

The annual 1,170,000 records of foreign S&T literature are translated from the world S&T literature pool of millions items. The production of foreign secondary publication has engaged 90% of funds and manpower in the Chinese secondary publication system.

The production of foreign secondary publication normally falls into the two categories: translation directly from foreign abstracting and indexing serial, and translation from abstracts in foreign primary journals. For example, the S&T information institute in Chinese Academy of Medical Science is responsible for the compilation of "the Foreign S&T Documentation Index (FSTDI) - Medical Science". It relies on 500 scientists in 41 academic institutions nationwide for the translation of bibliographic records of foreign journal papers. Because of the delay in foreign journal arrival to Chinese libraries and in translation, the time span between a foreign journal paper publishing and its bibliographic record appearing in FSTDI is some **21 months** on average which is **4** times the time span of Medical Index (4.5 months) (Jin, 1988).

Generally, the Chinese national S&T secondary publication system has the bibliographic control on most of high standard domestic S&T literature. However, the comprehensiveness in coverage of domestic literature is questionable. One example is from *"the Chinese S&T Documentation Index (CSTDI) - Medical Science"*. The CSTDI - Medical Science is the most comprehensive index serial on domestic literature in medical and pharmaceutical area in China. The S&T institute in Chinese Academy of Medical Science is responsible for the production of it. It is reported that each year the institute selects 38,000 items from its intake of 80,000-100,000 (journal papers from 400 Chinese journals, reports, monographs, patents, proceedings, grey literature etc.) for the compilation of CSTDI - Medical Science. In this case, less than 50% of Chinese S&T literature in medical science are covered by the national S&T secondary publication system.

Apart from *the Foreign S&T Documentation Index (FSTDI) - Medical Science* and *the Chinese S&T Documentation Index (CSTDI) - Medical Science*, the *Chinese Medical Abstracts* is a comprehensive source of information in medical sciences in China. It is published in 14 sections, covers about three hundred journals and indexes 21,000 records each year.

In October, 1989 the author visited the 20 staff editorial division of the *China Pharmaceutical Abstracts (CPA)* in SPAC. CPA is the most comprehensive abstracting journal for the domestic pharmaceutical literature in China.

CPA had been prepared since 1980 and was published in 1984 with a coverage of more than 220 Chinese journals. CPA is one of the first to be published with the assistance of computer typesetting in China. By 1989, there are 50,000 records stored in SPAC central computer. With the computer aid, CPA is published bimonthly with annual production of 9000 records in Chinese. Mainly serving the information needs of Chinese academic pharmaceutical institution libraries and pharmaceutical industry libraries, CPA has a subscription of 1,500 nationwide each year. The abstracts are informative and arranged in classified order with author, generic name and subject indexes which are cumulated annually. **Table 8.3** gives the classification of CPA.

Table 8.3 CPA Classification and Number of Records in 1989

Code	Heading	No. of records	% of total records in 1989
01	General theory in pharmaceutical sciences	107	1.2%
02	Pharmacognosy and TCM raw material	596	6.7%
03	Pharmaceutical Chemistry	562	6.3%
04	Pharmaceutical Development and Production	194	2.1%
05	Pharmacy and Formulation Development	502	5.6%
06	Pharmacology and Toxicology	1254	14.1%
07	Pharmacokinetics and Pharmacodynamics	225	2.5%
08	Pharmaceutical Analysis	745	8.4%
09	Clinical Evaluation and Use	4390	49.2%
10	Production quality control	80	0.9%
11	Factory Design and others	118	1.3%
12	New Drug Profile	142	1.6%

All the Chinese abstracting journals rely on government funds for publication. For the last three years, there has been a reduce in government funding for the national production of secondary publications which has resulted in the decrease in the number of Chinese abstracting journals and the number of bibliographical records (Table 8.2).

In China, the plan for building up domestic S&T databases in the forms of factual, numerical and bibliographical has been drawn since early 1980. Some progress has been made so far. By 1988, there are 262 domestic S&T databases in China, of which 98 bibliographical ones, 102 factual or numerical ones and 62 others.

However, so far only 61 of 262 (all are bibliographical) have more than 5,000 records. Of the sixty one databases, 9 are produced by Academia Sinica. The other 52 bibliographical databases are built up by about twenty ministries with mainframe computer facilities. All the Chinese databases are still at stage of inhouse use so far (Academia Sinica, 1991).

Table 8.4 lists some Chinese databases relevant to pharmaceutical sciences.

According to ISTIC 1985 statistic, there were 900 microcomputers and 50 minicomputers and 10 mainframes (with 1MB$^+$ and 1000MB$^+$ memory) among the 4000 S&T information services in China. Since then until 1989, the installation of micro-computers has increased by about 20%. However, there has been no increase in the number of mainframe. (Zeng, 1987 & White Paper, 1990).

Because of the lack in facilities and funds, none of the 61 Chinese bibliographical databases are online accessible so far.

8.1.4 Foreign Information Analysis & Research

Apart from primary S&T documents supply and abstracting & indexing services, the third of the three functions of the Chinese national S&T system is foreign information analysis and research.

This work started in the 1950s when many university graduates with first degree in *foreign language study* were employed by R&D institutions in academic sector and industry. They established *foreign information analysis and research* divisions in the institutions. The major functions of such a division include:

to receive requests from users (scientists, S&T administrative officials etc.);

Table 8.4 Chinese Databases Relevant to Pharmaceuticals With More Than 5000 Records By 1988 - (Academia Sinica, 1991)

File Name	Language	Journal Coverage	records by 1988	producer and host
China Chemstry and Chemical Engineering	Chinese	800	5000	Ministry of Chemical Engineering
Chinese Pharmaceutical Abstracts	Chinese	248	53,000	SPAC
China Biomedical Abstracts	Chinese	80	30,000	Chinese Academy of Medical Sciences
Chinese Patent Abstracts	Chinese		40,000	Chinese Patent Office
Clinical Medicine Abstracts	Chinese		10,000	Military Hospital System
Clinical Trial Abstracts	Chinese & English		7800	Shanghai Medical Institute of S&T Information
Chinese Chemical Abstracts	Chinese & English	592	70,000	Academia Sinica
Chinese Biological Abstracts	Chinese & English	300		Academia Sinica

to establish foreign information analysis and research projects on requests;

to search and collect relevant information by using all sorts of primary, secondary information sources wherever available;

to write reports or reviews based on the foreign information analysis and research;

to compile and produce subject bibliographies or reference tools;

to produce translated foreign information bulletins, serial, etc.;

to translate full text papers, reports, monographs on demands.

This work has spread to large S&T libraries such as the Beijing Library of Academia Sinica since the early 1980 when the library introduced a slogan "the combination of library service and foreign information research". According to ISTIC 1985 statistics, about 20% of library and information staff in 4000 S&T information organizations in China have the first degree in *foreign language study*. It is them who have created such a service with the Chinese characteristics aiming at overcoming foreign language barriers in S&T information communication. So approximately we may estimate that about 20% of Chinese information workers are engaged in *foreign information search*.

Each year, thousands of foreign information research reports, reviews, and subject bibliographies are produced by Chinese S&T information staff in the 4000 information organizations. In 1985, there were 34,000 items of translations, 7,741 foreign information research ongoing projects, 5,920 completed projects (reports and reviews) and 15,605 titles of subject bibliographies, bulletins etc (ISTIC, 1985).

During the 1980s, the following trends in foreign information analysis and research have been seen in China:

1. The reduce in the numbers of "foreign information analysis and research projects" (completed) from 5920 in 1985 to 2685 in 1989 (White Paper, 1990);

2. The switch from mainly serving scientists information needs to mainly serving S&T administrative officials information needs.

The above trends reflect the change in the foreign S&T information needs and use in China.

On one hand, Chinese scientists' ability of reading foreign language (especially English language) literature has been greatly improved during the 1980s. It was reported that 93% of Chinese scientists can read S&T literature in English; 27% can read Russian and 19% can read Japanese (Academia Sinica, 1991). And 50% of Chinese scientists do not regard "foreign information analysis and research" reports and reviews as high quality S&T information source (seeing Chapter 5).

On the other hand, Chinese S&T administrative officials' needs for foreign information has been increasing during the 1980s. The economic reform and the "open door" policy needs the decision making to be based on timely and comprehensive information work, while the foreign information analysis and research service could save time for the officials in searching, collecting and translating information. In 1986, ISTIC conducted a survey on S&T administrative officials information needs. The results showed that 65% of officials only use information in Chinese partly owing to lack of time and partly owing to inability of reading foreign languages. It also reported that 75% of officials regard "foreign information analysis and research" reports and reviews as a major and valuable information source. This kind of information service needs careful evaluation and assessment in the light of system objectives, performance and cost effectiveness, because it represents a significant part of S&T information work in China.

According to SPAC 1987 statistical data, during 1985-1986, the nine first grade information services completed more than two hundreds of foreign information analysis and research projects.

According to SPAC 1989 statistical data, 22 of 26 first and second grade information services in the SPAC provincial branches conduct "foreign information analysis and research". There are 209 staff in the 22 services with an average of 9 staff per service. In 1989, among the 22 services, the annual output of information research reports (projects) in a service ranges from one to twenty with an average of 6.

In addition, there are several foreign information research systems inside SPAC. Each has its speciality and its regular publications - bulletins, serial. There are 30 titles published by the nine first grade information services and 60 titles by the 25 second grade information services.

The author interviewed information officers in the following 5 systems in October 1989. Although by no means comprehensive, the five systems reflect the efforts and emphases on foreign information research and analysis in China.

(1)Shanghai Institute of Pharmaceutical Industry is the head organization in the foreign information analysis and research system specialised in Western Medicines R&D. Under its supervision, there are 20 large factories and R&D institutes cooperating to carry out foreign information analysis and research and publish a serial "World Pharmaceutical R&D" bimonthly with 10,000 subscription each year.

During 1985-1987, cooperated with the SPAC headquarter and the Chengdu service, the Shanghai information service has completed the central government level project "1980s World Pharmaceutical R&D Progress". It also completed another 12 large foreign information analysis and research projects during the period.

(2)Shanghai YANAN factory is the head organization in foreign information analysis and research system specialised in Drug Formulation and Preparation. Within the system there are about 10 factories exchanging information analysis and research reports, and publishing several titles of bulletins each year.

(3)Guangzhou Pharmaceutical Economic Information Service has been carrying out world and domestic market research on three categories of medicines since 1985.

(4)SPAC headquarter information service is carrying out a foreign information analysis and research project "Chinese and World Pharmaceutical Industry in 2000" for the State Plan Commission and the State Economy Commission. The project covers 6 subjects and 30 categories of medicines.

In addition, in cooperation with the nine first grade information services, it also conducts another large project "Pharmaceuticals Quality Control and Standard in the World".

(5) Jilin Province Pharmaceutical Information Service has conducted about 5 projects by "borrowing" 30 S&T staff from provincial factories since 1985. By 1987 about 20 reports or reviews were completed.

8.2 Business Information Flow

8.2.1 Outlook on the Economic Reform in Industry in the 1980s

The national economy of China is mainly a state-planning one, in comparison with market economy predominant in most of western countries. In other words, to a large extent the various level governments directly control production, commercial prices, employment and so on.

The state enterprises constitute the central theme of industry, which is supplemented by a great amount of small collective and individual enterprises.

The largest enterprises were all state-controlled, under the domain of the central plan and under the supervision of the central industrial ministries in Beijing (such as State Pharmaceutical Administration of China (SPAC)) and their branches throughout the country. Medium-sized enterprises were largely owned and administered by provinces and municipalities. Small-scale enterprises were owned and administered by localities (county, prefect, or village) or collectives; small businesses were primarily outside of plan control.

Before the economic reform (1979-), the economy was one of hidden shortages and inactive market. The 1980s economic reform was intended to decentralise control and to expand enterprise decision-making autonomy in an effort to raise output from the same input; and was marked by the continuous introduction of new reform measures. Two major measures are the **autonomy of enterprise management** and the **dual-price system** (Experimentation in industrial reform began in 1978 when existing plan quotas for some enterprises were adjusted to permit above quota output to be marketed independently at prices decided by enterprises according to the market demands). The process of extending reforms expended the operation of market mechanisms throughout the 1980s.

The transition has proved vital for the last ten year economical growth. Ten years after the reform, a surge of production, a rise in living standards, and an explosion in domestic trade and foreign trade have been seen by the world, in despite of some serious intensity in the national economy (seeing Chapter 2).

Correspondingly, the reform gives rise to Chinese industrial enterprises' demands for business information. However, the business information service was almost a vacuum in the Chinese information infrastructure until the end of 1980s.

In 1986, ISTIC conducted a series of surveys on Chinese enterprises' business information needs. It reported that although there have been ever-increasing demands among enterprises for market information, product information, and other business information, there is no business information services available for public use in China (ISTIC, 1986). To investigate the situation in Chinese pharmaceutical industry, the author conducted a survey during October and December in 1989. Fifty questionnaires were sent out to large pharmaceutical factories in Beijing, Shanghai, Guangzhou, and other big cities. Thirty of them replied. In addition, the author visited six large factories in Beijing and Shanghai, informal interviews were given to about ten information officers in the factories.

8.2.2 Industrial Enterprises' Needs for Business Information

All of the thirty six factories reported eager demands for products information, market information, Information on competitors, financial information and foreign trade information. Most of the factories (30) need statutory information (standards, import and export, governments legislation and regulations). Currently, Chinese factories are mainly competing among themselves in domestic market and in export of bulk pharmaceuticals, they are more interested in domestic market information than in world market of ethical drugs.

All the thirty six factories also reported eager needs for foreign technical information especially patent information. All the six factories the author visited expressed great interests in foreign pharmaceutical patent information. One of the factories has twice contacted the author after her return back to the UK, seeking some foreign patents which are not available in China.

According to the survey, few of the factories have formal business information personnel and divisions. There are two each having a business information unit, the others have product or market managers dealing with business information occasionally.

There are two major problems in business information. On one hand, because of lack of experience in operation under the new market mechanism, Chinese enterprises in general are not well aware of many potential information sources available. For example, the SPAC S&T information service network, with one head service, 9 first grade and 25 second grade services all over the country, has some business information sourcebooks, reference tools containing mainly foreign business information (Such as Scrip, Pharmaproject by PJB and Marketletter by IMS). And one third of the 35 SPAC information services have some kinds of economic or business information enquiry services (either on domestic or on foreign information). However, only 7 of 36 factories reported use of the SPAC information network for business information needs.

On the other hand, there are few information services being organized to collecting, disseminating and supplying domestic and foreign business information to the 236 large and medium-sized and two thousands small pharmaceutical factories, although there are some scattering business information flows inside the Chinese pharmaceutical industry.

All the thirty six respondent factories reported they rely on official channels (China National Cooperation of Pharmaceutical Industry, China National Cooperation of Medicine and China National Cooperation of Pharmaceutical Foreign Trade under SPAC) for product information and market information. Every year, the China National Cooperation of Pharmaceutical Industry **(CNCPI),** the China National Cooperation of Medicines**(CNCM),** the China National Cooperation of Pharmaceutical Foreign Trade **(CNCPFT)** (the three big corporations under SPAC), and the provincial and local governments hold many plan and market meetings. This kind of meetings or fairs are reported as the most important business information source for all the 36 factories; although the information flows are not well organized.

One plan and market manager in a factory told the author that each year he has to spend more than half of work time on travelling around the country and attending various market meetings and plan meetings. "There is no comprehensive, efficient and reliable business information source or service available nowadays. In some sense, the difficulty in gaining business information is bigger than the old days before the economic reform when there was always only one information source - the government departments. Now there is a free market. You hardly know exactly what is going on there".

Indeed, to access Chinese business information has become more and more difficult as the economic reform processes and more and more factories take part in free market economy. Even the top administration SPAC has lost the confident in mastering the national product information and market information.

To implement an effective control of the national pharmaceutical industry economic information, a national pharmaceutical product and market database has been under discussion in SPAC now.

8.2.3 Existing Business Information Flows

During the 1980s economic reform, the SPAC S&T information service network has gradually enforced its business information work. Under the SPAC administration, there are three subsystems with specialised functions - industrial production (administered by CNCPI), domestic market (administered by CNCM) and foreign trade (administered by CNCPFT). In each of the three subsystems there are some kinds of business information flow, so far not being well organized.

1. China National Cooperation of Pharmaceutical Industry

CNCPI and its 28 provincial branches are responsible for the plan and supervision of the production in about 900 large and medium pharmaceutical factories in China.

The 1980s reform has given factories more authority to sale their products at their own prices and via their own distribution channels. Since 1987, five industrial corporations have been established to promote and sale products for their member factories in domestic and world market. These corporations are composed of either several large factories with similar products or several provincial CNCPI branches (China Pharmaceutical Yearbook, 1987).

These industrial market forces have constitute a potential source of business information in China. However, none use of the potential information source was reported by the 36 respondent factories in 1989 survey.

2. China National Cooperation of Medicines (CNCM)

Under the administration of CNCM in SPAC, there are 5 national whole sale centres in Beijing, Shanghai, Guangzhou, Tianjin, and Shenyan; 28 provincial whole sale centres; 2300 county level whole sale centres and 26,000 retail stores over the country. Before the economic reform, this whole sale network under CNCM had monopolised the domestic market of Chinese pharmaceutical products. However, the 1980s reform has significantly reduce the power of CNCM monopoly. According to the production manager in Beijing Pharmaceutical Factory (among the top ten in China), now as much as 70% of the products of his factory are sold by the factory itself rather than by the CNCM.

Nevertheless, CNCM still is the biggest market force in Chinese pharmaceutical industry. Therefore it holds the most comprehensive source of business information on the domestic market.

Affiliated to the CNCM Guangzhou centre (one of the five national whole sale centres), the Guangzhou Pharmaceutical Industry Economic Information Service - one of the nine first grade information services in SPAC information network - is specialised in pharmaceutical business information on both domestic and world market.

It is the most used formal business information service in Chinese pharmaceutical industry. All of the 36 respondent factories in the 1989 survey reported some use of it.

It is among the only three information services (the other two - one in Shanghai and one in Shenyan) in the SPAC network which could make money (more than ¥100,000 per year) from providing information. Annual income of ¥550,000 from business information services was reported in Guanzhou Economic Information Service in 1988 and 1989. Its major work is to publish three titles of bulletins and to provide information to thousands Chinese pharmaceutical factories on demands and in charge. The three bulletins provide information and analysis on domestic pharmaceutical R&D, manufacturing, marketing and legislation mainly, supplemented by world pharmaceutical industry information. "Medicine Economic News" (weekly) and "Medicine Economy" (monthly) are the two formal publications which can be subscribed through the Chinese Post Office. The former contains timely news and the latter provides analyses, researches or reports. The "Medicine Economic Information" (monthly) is an inhouse bulletin which contains much more detailed domestic and world business information. Users can only subscribe it directly from the Guanzhou Economic Information Service.

Under the supervision of the Guangzhou Economic Information Service, there are a national pharmaceutical industry economic information network being under establishment with 19 first class branches and 148 Second class branches. The network is to link 4000 factories, whole sale stores and hospitals in the whole country, to exchange business information among the nodes and to provide business information over the country.

The case of Guanzhou economic information service and the cases in Shanghai and Shenyan pharmaceutical information services, reflect the fact that there are big demands for business information in Chinese pharmaceutical industry and existing S&T information services are able and willing to add business information function to their traditional S&T information work.

3. China National Cooperation of Pharmaceutical Foreign Trade

CNCPFT is the monopoly company dealing with import and export of pharmaceutical products. It is a potential business information source for Chinese and foreign pharmaceutical enterprises. However, there were no reports on the use of CNCPFT as business information source by the 36 Chinese respondent factories in the 1989 survey.

4. China Enterprises Directory Database (CEDD)

CEDD is a directory database in Chinese language newly established by ISTIC and is in service since July 1991. CEDD covers 25,000 industrial and commercial enterprises in China. Its English version is still in building. The database provides online searching in ISTIC centres in Beijing and Chongqing.

Although there are many business information sources and services in the developed western countries, the information is very difficult for Chinese factories to access. The major reason is the lack of hard currency and the huge cost of those foreign information.

For example, the Shanghai Pharmaceutical Administration Branch of SPAC has recently spent half of its annual acquisition budget (£1610 in 1989) to subscribe PHARMPROJECT- a monthly updated information system (hard copy) by a UK publisher PJB Ltd. (seeing Chapter 7). The data sheets have been reported to be very heavily demanded and used by hundreds of factories in and around the Shanghai city.

The trends in business information development in Chinese pharmaceutical industry are

1. For S&T information services in SPAC (9 first grade and 25 second grade) to add business information function and provide fee based services;

2. For the three big corporations in SPAC - CNCPI, CNCM, and CNCPFT to organize the fee based business information services within their systems;

3. For the newly established industrial market and sale corporations (there are already five) to organize the fee based business information services within their systems;

4. Demands and market for Chinese and world business information will continue to grow, in the mean time, more and more organizations (both traditional S&T information services and government plan and market departments) will attempt to control some business information resources and make profit by providing fee based information services.

8.3 Drug Information Flow

About drug information services provided by the pharmaceutical industry and hospital based drug information (DI) centres in the UK, there have been a certain number of surveys and reports since 1980. To compare the situation in UK and China, we conducted a similar survey during October and December of 1989 in China. Questionnaires were sent to 100 doctors and 100 pharmacists in 20 big hospitals in Beijing and Shanghai; and to 50 large factories; 49 doctors, 52 pharmacists and 36 factories replied respectively.

(a) Sources of new drug information

The channels Chinese factories using to promote the products are similar to those used by UK companies. All of the 36 factories using promotion literature in academic journals, in trade press, in radio and television advertisements. All of the factories rely on plan and market meetings or fairs held by various level governments and various kinds of organizations. All the factories send medicine representatives to users at whole sale centres and at hospital pharmacy.

Table 8.5 show the sources of new drug information for doctors and hospital pharmacists in China.

Table 8.5 Awareness of New Drug By Chinese Doctors and Pharmacists

	of 49 respondent doctors	of 52 repondent pharmacists
promotion literature	24	37
promotion meetings or fairs	7	27
posted advertisments	4	21
factory representatives	4	19
whole sale centre representatives	7	27
hospital pharmacists	26	-

Table 8.6 Problems Occur to Chinese Doctors and Sources They Use for the Information (as % of 49 respondents)

	inquiring pharmacists	rank	inquiring factories	rank	self solution	rank
administration /dosage (100%)	40%	4	6%	3	54%	5
adverse effects / toxicology (100%)	24%	6	10%	2	66%	3
availability /supply (100%)	70%	1	10%	2	20%	8
clinical use (100%)	18%	7	4%	4	78%	2
identification (100%)	62%	3	14%	1	24%	7
interaction (100%)	16%	8	4%	4	80%	1
pharmacology (100%)	34%	5	2%	5	64%	4
pharmaceutical problem (100%)	68%	2	4%	4	28%	6

Promotions by Chinese factories are not aimed at doctors directly. Chinese doctors mainly rely on hospital pharmacists for new drug information while hospital pharmacists act as intermediary between doctors and pharmaceutical factories and between doctors and whole sale centres. As in the developed countries, Chinese doctors produce many clinical reports/papers on their prescribing experience. Academic and professional journals, magazines and newspapers constitute a rich information source for post marketing surveillance. In 1992, a professional medical journalists association was founded in China with several largest newspapers, magazines and TV stations involved.

(b) Types of enquiry raised by doctors and received by hospital pharmacists and by pharmaceutical industry

The problems which occur to doctors are similar in the UK and China, including *administration/dosage, adverse effects/toxicology, availability/supply, clinical use, identification, interaction, pharmacology and pharmaceutical problems.*

At present, there are no formal drug information service in Chinese hospitals. Nor full time pharmaceutical information pharmacists or officers. 44 of 52 Chinese respondent pharmacists reported providing drug information only as part of their jobs while the remainders do not participate in any sort of information work. **Table 8.6** shows problems occurring to Chinese doctors and the sources they use for the information.

It seems that Chinese doctors rarely use industry information source. This result agrees with the other survey result that majority of Chinese pharmaceutical factories do not provide medical information services for external enquiries.

They mainly rely on hospital pharmacists for the following information (in order of usage):

(1) availability/supply, (2) pharmaceutical problem, (3) identification, (4) administration/ dosage.

They mainly use own knowledge or read professional journals for the following problems (in order of usage):

(1) interaction (2) clinical use (3) adverse effects/toxicology (4) pharmacology and (5) administration/dosage.

(c) Medical information services provided by pharmaceutical industry

None of 36 respondent Chinese pharmaceutical factories have a medical information section or unit. There is no formal channel for communication between Chinese pharmaceutical industry and health professionals on use of medicines. This result agrees with the other survey result that Chinese doctors rarely use pharmaceutical industry information source.

(d) Traditional Chinese Medicine Information

For thousands of years, Chinese people have employed a variety of ways of dealing with disease. For 80% of the population living in rural areas, TCM is still the major if not the only form of treatment available to them (seeing Chapter 3). Moreover, even in cities or towns where the modern health care available to the population, people continue to seek traditional treatment. Sometimes this traditional treatment is more expensive or difficult to get because there are far less TCM doctors and hospital beds than WM ones (a ratio of 2:98, seeing Chapter 3). However, TCM treatments are valued because they are offered in terms that patients can understand or in the context of cultural values and practices that shared by patients and doctors alike.

It must be pointed out that the modern scientific R&D, education and clinical practice of TCM did not start until 1949 when the People's Republic of China was founded and the half century of wars were ended. Since 1949 in China, TCM R&D, education, and clinical practice have progressed gradually but not as fast as that in WM. One example is that currently there are about 900 WM factories comparing to only 500 TCM factories, there are 92 WM universities with 129,000 students annually enrolled comparing to 24 TCM universities with 29,000 students annually enrolled (seeing Chapter 3).

As a result, TCM information work is small in scale comparing to that for WM in China. Today, there are 40 TCM libraries and 400 TCM documentationists in the country (TCM 1949-1989). By comparison for WM information, there are 35 information services within SPAC administrative system, plus 57 SPAC research institution libraries or information services (seeing §8.1.1 and Chapter 3).

One of the major task of TCM information work is the preservation and revision of ancient documentation. There are about 13,000 titles of such documentation being collected and stored in about 115 libraries in China. During 1965-1975, MPH has completed the revision of 7 titles of them. During 1982-1990, it has greatly raised the number of revision to 600 titles.

In 1961, China TCM Academy and the National Library published the first "National Union Catalogue of TCM Documentation" of 7661 titles in 59 libraries nationwide. In 1986, the second edition of 12,124 titles in 115 libraries has been published, which covers TCM documentation published before 1949.

During April, 1986- July, 1988, China TCM Academy has established a manual index database of 123,000 TCM papers and documents published in China after 1949. A computerized database containing 50,000 records has also been set up to provide inhouse searching and to aid indexing journal publishing. (TCM 1949-1989)

Generally, in China TCM information work is still at the stage of preservation and revision of old documentation and is gradually proceeding into a stage of collecting, storing, retrieving and disseminating information to users. There are some causes for the comparatively slow progress in TCM field. One is the less emphasis on TCM R&D, education and clinical practice than that on WM. The shortage in resources for TCM R&D, education and practice has prevent the information work from fast progressing. The other reason may be more complex. Because the way in which TCM treatments are given is so different from that in WM treatment, TCM doctors may not able to or may not willing to provide any information on (1) interaction (2) clinical use (3) adverse effects/toxicology (4) pharmacology (5) pharmaceutical problem (6) identification, though these information are essential for WM clinical practice. On the other hand, patients do not usually ask for the above information from the doctors, since these treatments have lasted for so long (mostly for several generations) without problems.

8.4 Statutory Information Flow and Chinese Regulatory System

Since 1949, China has built up its own medicines control system which contains four parts- (1) Medicine Administration Bureau in Ministry of Public Health (MPH) (2) Medicinal Product Analysis Institutes (3) Imported Medicine Analysis Institutes (4) Chinese Pharmacopoeia (first edition in 1953). In 1985, China formally introduced **the Medicine Act (1985).**

The Chinese Medicine Act (1985) includes 11 chapters and 60 instruments. The chapters are:

1. Guide-lines 2. Administration of Pharmaceutical Industry 3. Administration of Pharmaceutical Whole Sale and Retail 4. Administration of Hospital Pharmacy 5. Control of the Quality, Safety and Efficacy of Pharmaceutical Products 6. Store and

Package of Pharmaceuticals 7. Control of Special Drugs 8. Labelling and Promotion of Pharmaceutical Products 9. Inspection of Manufacturers, Wholesalers and Hospitals 10. Legal Responsibility 11. Appendix.

In May and June of 1986, a delegation from China MPH visited UK and Japan to study the medicine regulation and legislation in the two countries under the WHO plan. For the past five years, improvements have been gradually made to enable the Chinese Act up to the world standards and compatible to USA and UK, Japan medicine acts or regulations.

The Administration of the Act

In the Act, the Medicine Administration Bureau in Ministry of Public Health (MPH) is the highest medicine control authority.

The Licensing System

The licensing system is the Chief novel feature of the Act. The system ensures that medicines are of good quality, safe and efficacious and are manufactured and dealt with under optimum conditions. The system also enables batches of products to be traced and withdrawn from sale with minimum of delay should they prove sequentially to be defective. The system utilizes five types of licence and two types of certificate each of which permits a person to engage in certain specified activities, namely- manufacturer's licences, wholesale/retail dealer's licences, medicine preparationer's licences, and export/import medicine product licences; clinical trial certificates and new medicine product certificates.

Because the Chinese Medicine Act has had a very short history (came into force in July, 1985), not only the Act itself is very brief but also the implementation of the Act has many problems. To establish a national, provincial, county level medicine administration network to implement the Act is still being discussed but not realized.

During the 1980s, the major task of medicine regulation has been focused on setting up **Good Manufacture Practice (GMP)** in China. In 1988, Chinese GMP came into force formally. All pharmaceutical factories need to pass GMP examination first, then will be granted the Manufacturer's licences.

Sections 21 and 22 of the Act deal with the licensing procedure of new medicine products. The Medicine Administration Bureau in Ministry of Public Health (MPH) appoint a **Committee for New Medicine Approval** (similar to CSM in UK).

Generally the Chinese requirements are comparatively simple or with low standards.

An example of this is from the difference in clinical trial requirement between China and developed countries.

The Chinese Act divides clinical trials into three phases rather than four phases in UK and USA:

Phase I requires not less than 30 case studies.

Phase II requires not less 300 case studies. The number of pre-market clinical trials is quite low in China comparing to 1-2000 trials required in USA.

Another example of the backwardness in Chinese medicine control system is the ADR monitoring or post market surveillance. In 1964, a yellow card system has been set up and in operation in UK under which doctors spontaneously report ADR to the public and the government authority. In China, monitoring ADR has been put on the agenda only since 1988 when 10 large hospitals in Beijing and Shanghai was appointed as the first batch of ADR monitoring centres.

For the past five years significant progress and improvement have been made in the medicine control field in China. Before the introduction of Medicine Act in China in 1985, the "new drug" production and market was not able to under the overall control of the central government. In 1985, there were 600 "new drugs" launched on the domestic market. However, after the Medicine Act in force, from October, 1985 to July, 1987, there were only 39 approved new drugs out of 100 applications being launched on the domestic market. From Oct., 1985 to July, 1989, 158 new drugs have been granted *new medicine product certificates,* with an average number of 40 new drugs per year.

Despite of all these progress and improvement, the Chinese legislation standards and information requirements are still quite simple, especially in the case of TCM[12].

A comparison of information requirements by the Chinese authority for WM new drug and TCM new drug is given in **Table 8.7**.

12 In 1987, there are 32 WMs and 11 TCMs being approved for marketing by the Chinese authority.

Table 8.7 Information Requirements for a New Drug Application
(source from MPH Beijing, 1989)

To apply for a product licence, the applicant must provide scientific evidence of (1) Chemistry and Pharmacy (2) Experimantal and Biological Studies (3) Clinical Trials.

	WM new drug	TCM new drug
1.	Product name, chemical name, Latin name etc.	Product name, Latin name etc.
2.	Chemistry of drug substance:a various names, physical form, structural and molecular formula, molecular weight etc.	Product formula and preparation process
3.	Chemistry of drug substance:b method of synthesis, method of manufacture, specifications of starting materials, reagents and solvents, purification method etc.	Chemical and physical studies relevant to quality control
4.	Development of assay methods evidence of molecular structure and physical characteristics, tests for identity, standard of potency and purity etc.	Chemical and physical characteristics of active ingredients
5.	Development pharmaceutics and biological availability an outline of work for determining satisfactory nature of the proposed formulation for its intended purposes	Chemical and physical comparative studies on man made substitute vs. TCM raw material
6.	Pharmacology	TCM theories which form the foundation of the formula
7.	Acute toxicity	Development pharmaceutics and biological availability an outline of work for determining satisfactory nature of the proposed formulation for its intended purposes
8.	Chronic toxicity	Pharmacology
9.	For drug administered by a particular route, it needs special studies of pharmacokinetics and toxicity by that route	Acute toxicity

continued

10.	Interaction studies	Chronic toxicity
11.	Mutagenic properties	Mutagenic properties
12.	Effects on the foetus and neonate	Effects on the foetus and neonate
13.	Oncogenetic (carcinogenic) properties	Oncogenetic (carcinogenic) properties
14.	Drug addiction	Short term stability
15.	Pharmacokinetics	Quality control specifications for clinical trial drug Analytical results of different batches of the product (3-5 batches)
16.	Short term stability	TCM raw material
17.	Quality control specifications for clinical trial drug Analytical results of different batches of the product (3-5 batches)	Preclinical brochure
18.	Preclinical brochure	Long term stability
19.	Clinical pharmacokinetics	Quality control specifications for finished product Analytical results of different batches of the product (3-5 batches)
20.	Clinical metabolism studies	Clinical trial reports
21.	Long term stability	Packaging
22.	Quality control specifications for finished product Analytical results of different batches of the product (3-5 batches)	
23.	Clinical trial reports	
24.	Packaging	

The information requirement for TCM new drug, unlike that for WM, does not include product chemical name, compound chemical structure. Chemistry of the drug substance is the major omission.

Also the pharmacological studies and clinical trials are less sophisticated in TCM than in WM. In the long term, standards and information requirements for TCM new drug will gradually be raised and improved along with the progress made in TCM R&D, education, and clinical practice in China. Finally, as the mechanism of medicine control becomes more mature in China, ***statutory information flow*** will grow significantly and become one of the major information flows.

8.5 Patent Information Flow and Chinese Patent System

In developing countries, patent protection for pharmaceuticals has two aspects. On one hand, it can provide a favourable atmosphere for foreign investment, protect domestic innovation, foster foreign innovation in drugs that have their main markets in developing countries, and facilitate domestic licensing. On the other hand, patents have often been used to secure import monopolies (stopping the importation of cheaper products) and to prevent local manufacturers from producing similar products.

Nowadays pressure from research based pharmaceutical industry in the developed countries is mounting in favour of product protection in developing countries and extension of the patent term from 15 years to 20 years and more in developed countries (China Daily, 22 May 1991 and 25 May 1991). The principal reason is to compensate for the time taken to complete the increasingly stringent tests and trials required by the authorities to establish safety and efficacy.

The first patent law of the People's Republic of China was promulgated in March 1984. Furthermore, the National People's Congress made a decision that China is to accede to *the Paris Convention for the Protection of Industrial Property*. The Chinese Patent Law has been effected since March 1985. In this way China clearly declares that it will provide legal protection for industrial property in the technological exchange between it and the rest of the world.

Following the record rush of 3455 applications on 1 April of 1985, the first day when the Chinese Patent Law went into force, as many as 50 applications have kept flooding into the Chinese Patent Office each day since then. By the end of September 1990, for the last 5.5 years Chinese Patent Office has received patent applications of 155,360 with an average **28,000 applications per year** accounting for 2.8% of the world annual number of patent applications. Of the total applications for the past 5.5 years, 81.5% are from domestic applicants and 18.5% are from foreign applicants. For the past 5.5 years China has granted 56,463 patents, of which 90% to domestic applications and 10% to foreign applications (Zhou, 1987 & People's Daily, 1 November, 1990). The foreign applications have come from more than 60 countries in the world and reached the amount of 28,682 by September 1990 (People's Daily, 1 November, 1990).

Because it is only six years old, the Chinese Patent System is still in a premature status. So far, pharmaceutical products and substances obtained by means of a chemical process have all been excluded from protectable subject matter according to Article 25(4) and (5) in the Patent Law.

Professor C. S. Zheng, the deputy director of International Law Division in Chinese Academy of Social Sciences has described the situation concerning pharmaceutical patent protection in China.

"After publication of the Patent Law (in 1984), a number of complaints were received on these exclusions (of pharmaceuticals and chemicals) from abroad. Similar criticisms have also appeared concerning the exclusion of food and pharmaceutical products (especially the latter) form Chinese interested parties.

"Traditional Chinese medicines frequently combine food with medicine have been scientifically proven to work quite effectively in curing certain chronic or stubborn diseases. In some international technology exhibitions, foreign experts often speak highly of such "food-medicines" innovations from China, while we ourselves refuse to protect them.

"As far as pharmaceutical goods are concerned, they must under the present law always be put on the market with their ingredients indicated clearly on their packages in order to avoid any harmfully effects. To exclude such products from patentable subject matter may make it easier for imitators. Furthermore, and as a matter of fact, many Chinese inventions in the field of pharmaceuticals have been prominent for a long, long time. Even before the existence of the (Chinese) Patent Law, certain Chinese pharmaceutical product inventions had been granted as patents in Japan and in various western countries.

"The main reason in deciding not to protect pharmaceutical products during the drafting of the Chinese Patent Law, may have been that a 15 year term for the invention might not have been considered in the public interest. The Indian solution, which is to make pharmaceuticals patentable yet to provide a shorter term of protection, may be a desirable route for China to follow. To date at least certain experts in the medical, health and legal fields have made such a suggestion." (Zheng, 1987)

A Chinese official has recently expressed that the Chinese Patent Law is now under adjustment. The expansion of patent life from 15 years to 20 years and the inclusion of pharmaceutical patent protection have been reviewed and considered (People's Daily, 25 May 1991).

Although so far in China there is still no patent protection for pharmaceuticals and there are few Chinese pharmaceutical patents in the world, the pressure from inside and outside China for the pharmaceutical patent protection in China have made it inevitable that sooner rather than later such a protection will be established in China.

Having said all that on patent protection, now we look at the patent information practice in China.

The centralized national patent document service was established at Institute of S&T Information of China (ISTIC) in Beijing in 1965. In 1981, the patent library was transferred to the Chinese Patent Office (CPO) for establishment of the Chinese Patent (Protection) System. In respect of the patent documentation practice, the CPO was confronted with a totally new situation after the promulgation of the Chinese Patent Law. The former document service to the public could no longer suit well the forthcoming needs. The need of building up a classified search file system to serve the examining procedure arose suddenly.

In "the story of the Chinese search files", J. L. Shen (1990) has described how a search file system of 3.65 million patent documents from EP, US, WO and China; and 3.62 million patent abstracts from 9 countries has been built up during eight years (1981-1988). Most of work has been done manually.

With the industrialization proceeding, more and more S&T workers and industrial enterprises have recognized the value of patent as an important technological and economic information source. During the author's survey in 1989, all of 56 R&D scientists in Chinese pharmaceutical sciences and all 36 large pharmaceutical factories who responded have expressed eager needs for patent information (at present that means foreign patents).

At present, the CPO publishes each week, the Patent Gazettes for Invention, for Utility Model, and for Design; Unexamined Applications; Examined Applications and etc..

One computerized database has been built up by the CPO, which contains 60,000 Chinese patent abstracts by 1990 with about 10,000 records adding in each year. This database has both Chinese version and English version (Academia Sinica, 1991). The major world patent databases such as CA, Derwent and INPADOC all have covered Chinese patents. The *Chinapats* (Chinese patent abstracts database) is now available on *ORBIT*.

Access to patent documents and patent information in Chinese libraries has been improved during the 1980s, partly owning to the efforts made by the CPO in the propagation of patent knowledge, the co-ordination of national patent information service system with 62 nodes in the country; partly owning to the enhancement of patent document services in other thirty or so S&T libraries around the country.

Now, there is a national patent information service network with the head service *Patent Documents Library* in Chinese Patent Office and 62 branches around the countries.

During the last 20 years, the CPO library has collected as many as 13 million patents from 15 foreign countries and two international organizations (EPO and WO) in the world (Shen, 1990 & Xu, 1989).

The collection was made by purchase during the period of 1950-1985. After 1985, most of foreign patents have been obtained through bilateral exchange, although there are still certain amount of patents being purchased. The average annual intake of patents in Chinese Patent Office are around two million foreign patent documents and more than twenty thousands domestic patent documentation. In 1989, Chinese Patent Office imported one million foreign patents in hard copy and 0.7 million in microfilm. The Chinese Patent Office library annual intake of world patents nearly equals to SRIS of the British Library (Zhao, 1991).

The CPO library has also been equipped with all major international secondary publication tools on patent information.

Each day the CPO library receives about 150 readers (or 50,000 readers per year) from all over the country. In recent years, an average of 1.5-2 million pages of patents (or about **100,000 patent documents**) have been photocopied for readers or external users each year (Shen, 1990). About 60% of users' needs are for chemical and pharmaceutical patents according to the CPO library statistics on about 1700 readers' requests for a period of two months. About 34% of requests are for US patents, 21% for Japan patents, and another 21% for UK patents, 10% for German patents, 9.5% for USSR patents, and 5% for other countries. A microfilm reading room was set up in 1987, which has collection of patent documents from US, Japan, Germany, France, Australia and PCT as well as Derwent's indexes (Xu, 1989).

The 62 local patent information services are set up to constitute the national patent information network in 1985. Their main function is to disseminate patent publications and patent documents published by Chinese Patent Office. They acquire patent documents and patent publications from the CPO at discount price and provide **Chinese patent** information and document service to local people. The use of the 62 services are relatively small at present - only 80 readers per working day.

Apart from the CPO library in Beijing, there are other 34 S&T libraries providing patent information and document service- ten in the government ministries in Beijing and 24 in provinces. The 34 patent libraries have certain amount of foreign patent collections. Except Chongqing Centre of ISTIC and Zhejiang Province, other patent libraries have much less annual intake than the CPO library in Beijing. As other kinds of imported information materials, foreign patents are concentrated in a few biggest cities such as Beijing, Shanghai, Chongqing. In 1985, China imported about 8-9 million foreign patent documentation (including duplicates). Of the nine million patents, Chinese Patent Office (Beijing) imported about 2 million, Chongqing ISTIC imported about 1.23 million, Zhejiang Province imported about 1.13 million, other 4 million foreign patents are among thirty provincial and ministerial patent libraries around the country (ISTIC statistics, 1985). However, there is no co-ordination or network among the 34 patent libraries and the CPO library.

8.6 Concluding Notes

Much greater emphasis on scientific information work than on business information and drug information work has been found for long time. Since 1949, the S&T modernisation has been regarded as the first important factor for the development of national pharmaceutical industry. On the other hand, in China until the mid 1980s, the importance of business information have long been overlooked, because of the predominantly central government controlled economy and the self sufficient nature of the pharmaceutical production. Because the major problem in drug consumption in China has been how to meet the domestic demands for essential drugs, the other problems common in developed countries such as information provision for health care personnel and the public, the post market surveillance etc. are still not on the agenda. The statutory information flow is still at its infancy, while China just started to introduce and is still enhancing the Medicine Act (1985) so that China could reach the world standard on new medicine registration. So far, there has been no pharmaceutical patent protection system in China. The major argument is that in countries with developing pharmaceutical industry, a weak patent protection for pharmaceuticals would ensure its potentially restrictive effects on domestic development to be minimised. Consequently, there is no pharmaceutical patent information outflow from China.

Chapter 9 Pharmaceutical Information Flow in China Today and in the Future

Chapters 7 and 8 have had an overview on pharmaceutical information flow in UK and in China, which shows the current Chinese pharmaceutical information flow is still underdeveloped. With the soft systems thinking, in this chapter, we will define a conceptual system model which is very much drawn from the UK situation; compare the current Chinese problem situation with the conceptual system model and propose recommendations for the future Chinese pharmaceutical information flow system.

9.1 Assigning UK Pharmaceutical Information Flow to a Conceptual System Model

Using Checkland's definition for the system model (**Figure 9.1**),

S is a formal system if and only if:

1. S has an ongoing purpose or mission.

2. S has a measure of performance. This is the measure which signals progress or regress in pursuing purposes or trying to achieve objectives.

3. S contains a decision taking process.

4. S has components which are themselves systems having all the properties of S.

5. S has components which interact, which show a degree of connective such that effects and actions can be transmitted through the system.

6. S exists in wider systems and environments with which it interacts.

An environment of S is further composed of environmental or influential factors which have some sorts of influences or impacts on the system. And normally the factors at a higher system level would also affect the lower level of systems.

7. S has a boundary, separating it from its environments and wider systems.

8. S has resources which are at the disposal of the decision taking process.

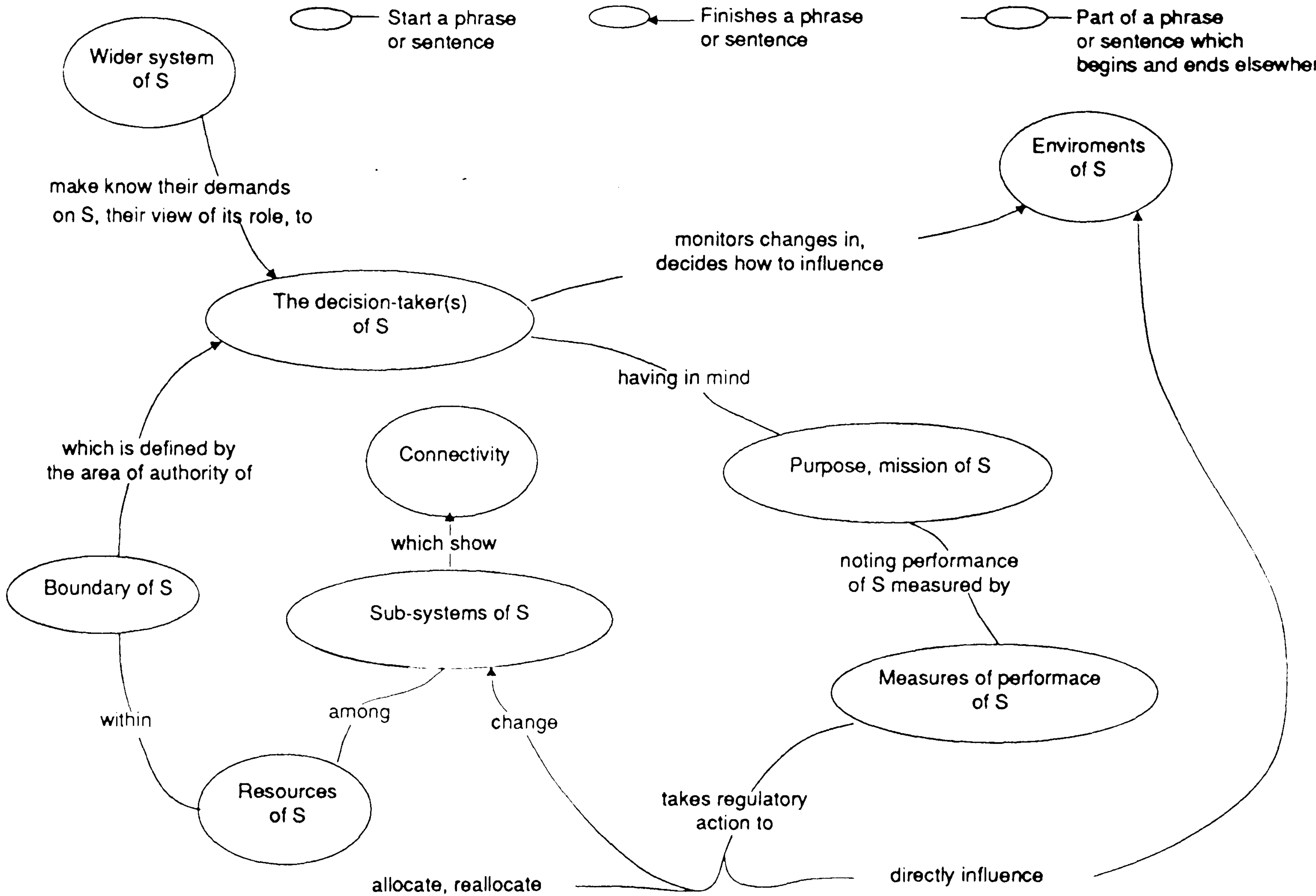


Fig 9.1 A model of the concept 'human activity system' (after Checkland, 1981)

9. S has some guarantee of continuity, is not ephemeral, has long term stability.

Note that if the analysis is pressed to lower levels, then below sub-systems, sub-sub-systems etc. will eventually be found items which are not systems at all but only system components.

Similarly, analysis in the other direction will eventually reach larger entities which have to be taken as environments rather than wider systems. The distinction being that an environment may hopefully be influenced but cannot be "engineered".

Now let us start to assign *the UK pharmaceutical information flow* to the conceptual system model.

1. Pharmaceutical information flow in a nation is the target system S.

2. The nation's pharmaceutical industry (including pharmaceutical R&D, manufacture, distribution and marketing etc.) is the wider system.

3. Purpose and mission of S and the decision making process in S

A well organized pharmaceutical information flow in a nation would function as the nerve system of the national pharmaceutical industry. It is closely associated with national pharmaceutical activity, serving information needs of pharmaceutical manufacturing and marketing, pharmaceutical R&D, safety use of medicine, and medicine regulation and legislation; so that:

(1) The national pharmaceutical industry could provide the great range of effective and safety tested therapeutic agents at a proper economic level, could make contributions to the original scientific discovery and to the development of practicable medicines as well as to their safe dissemination.

(2) The national medicines research could occupy the scientific and technological front, by comprehending the basic nature of disease and the mechanism involved in the healthy functioning of the body so that new medicines could be discovered and developed to provide treatment and prevention for a wide range of diseases.

(3) The national medical personnel, other prescribers and the public could be rational in their use of medical products.

(4) The national regulatory system could be in full control of the drug situation in the country. An ideal national regulatory system for medicines is not only responsible for ensuring that medicines on sale are safe, effective and properly labelled, it also controls the investigation of new agents and monitors adverse drug reactions.

In fact, the UK pharmaceutical information is an existing situation rather than a planned system. Because of the British political framework, there is no central decision taking process but decisions are made in pharmaceutical companies, in the NHS, in business information services etc.. Because of the centralized government system in China, decisions on any future pharmaceutical information flow system will be made by a central government department.

4. Measures of performance of S

In the social process of information transfer, the ultimate evaluation must be from the viewpoint of the potential recipients or users. *Have they received the information needed, wanted, demanded and are the costs of this information provision personally or socially acceptable?* There is also the question of evaluation from the viewpoint of the sources of information, who are concerned to know *whether they have got their messages across, to whom and with what effect* (Vickery, 1987).

In this study, we "measure" the performance of scientific information flow in terms of scientists' information accessing searching disseminating and using ability.

5. Boundary of S and Environment of S.

Pharmaceutical information flow is the information flow existing within the national pharmaceutical industry (the wider system). It is influenced by its special environment and its general environment.

6. S has the five subsystems - scientific information flow, business information flow, drug information flow, statutory information flow and patent information flow. There are connective and interacts among the subsystems; such that effects and actions can be transmitted through the system.

7. S has resources at the disposal of the decision taking process. Again in UK pharmaceutical information flow, resources are decentralized at different decision taking processes. However, with the future Chinese pharmaceutical information flow system, resources will be under the central control.

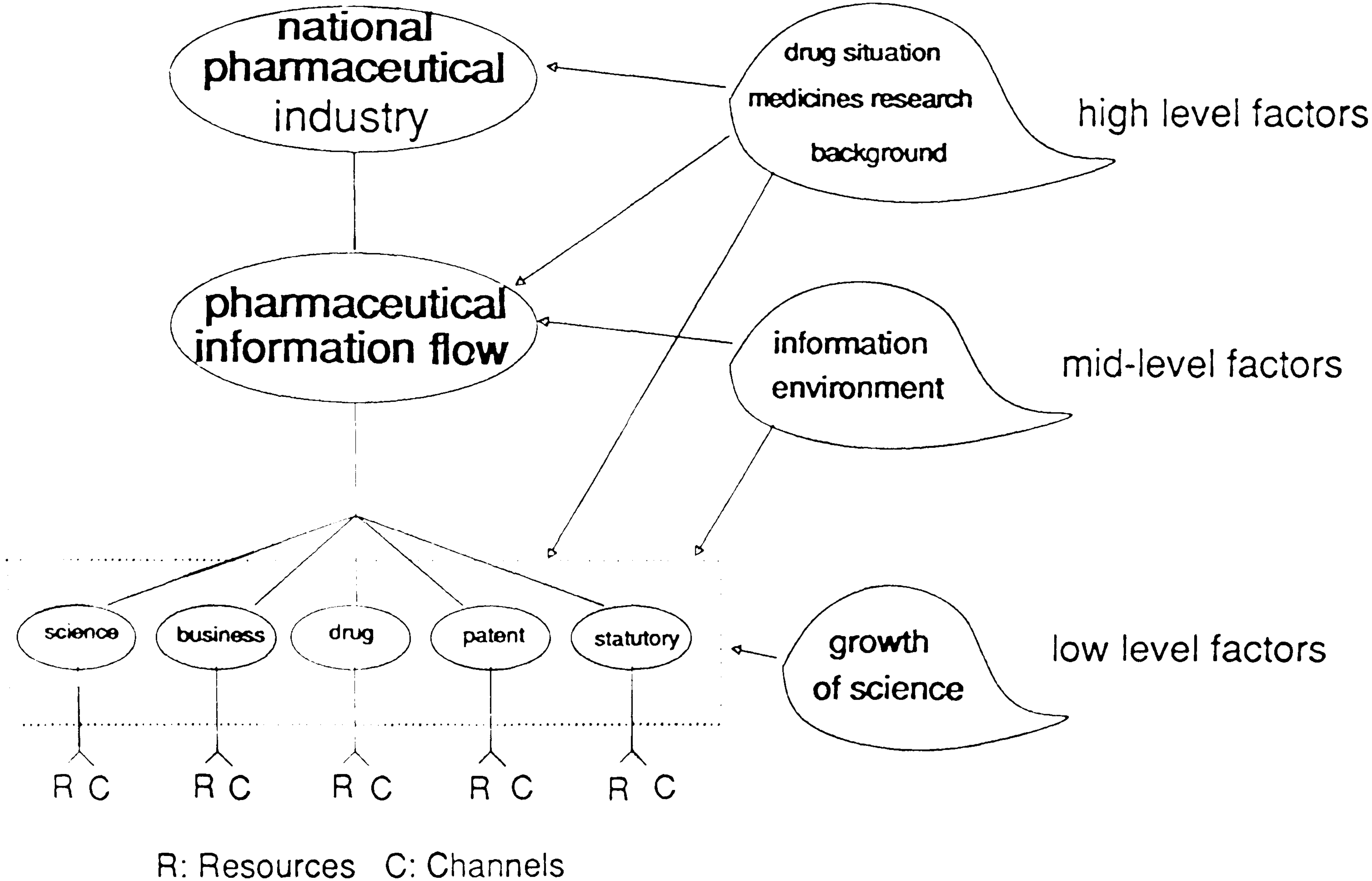


Fig 9.2 Conceptal System for Pharmaceutical Information Flow

So far we have defined a conceptual system model based on UK pharmaceutical information flow in Figure 9.2. Next we will compare the Chinese pharmaceutical information flow with the conceptual model. Table 9.1 is a summary of the plan for comparison in this chapter.

Table 9.1 Plan of Systematic Comparison

Subject	Comparison	Section
System S: pharm. infor. Flow	Infrastructure	§9.2
Wider system: national pharm. industry	Purpose/mission	§9.3
System S: pharm. infor. Flow	Purpose/mission, decision taking	§9.4
System S: pharm. infor. Flow	Performance	§9.5
System S: pharm. infor. Flow	Resources	§9.6
Subsystems: scientific, business, drug, patent and statutory information flow	Relationship among subsystems	§9.7
Special environment: drug situation/pharm. activity	Relationship with system S	§9.8
General environment: infor. environment	Relationship with system S	§9.8

9.2 Pharmaceutical Information Infrastructure in the Two Countries

Comparing Figure 7.1 and Figure 8.1, we find the following differences in pharmaceutical information flow infrastructure between China and UK.

CHINA

Much greater emphasis on scientific information work than on business information and drug information work has been found for long time. Since 1949, the S&T modernisation has been regarded as the first important factor for the development of the national pharmaceutical industry. On the other hand, in China until the mid 1980s, the importance of business information has long been overlooked, because of the predominantly central government controlled economy and the self sufficient nature of the pharmaceutical production. Because the major problem in drug consumption in China has been how to meet the domestic demands for essential drugs, the other problems common in developed countries such as information provision for health care personnel and the public, the post market surveillance etc. are still not on the agenda. The statutory information flow is still at its infancy, while China has just started to introduce and is still enhancing the Medicine Act (1985) so that China could reach the world standard on new medicine registration. So far, there has been no pharmaceutical patent protection system in China. The major argument is that in countries with developing pharmaceutical industry, a weak patent protection for pharmaceuticals would ensure its potentially restrictive effects on domestic development to be minimised. Consequently, there is no pharmaceutical patent information outflow from China.

Today the national S&T information system plays a central role in the pharmaceutical information flow infrastructure in China.

The UK

A much more comprehensive pharmaceutical information flow, including scientific, business, drug, statutory and patent information, is found in the UK pharmaceutical industry and pharmaceutical activity; comparing to the situation in China.

In view of the highly competitive market situation, the UK pharmaceutical industry companies are careful to protect their intellectual property by means of patent protection. Most research work in pharmaceuticals is targeted not only scientifically but also commercially. There is a substantial and continuing demand for information concerning regional disease profiles, health care systems, market sizes, regulatory constraints, competitor activities, sales statistics, and so on. It is very clear that the heavy R&D investment has partly gone to scientific information work in the industry. *"The necessity of retrieving information from external sources has led to increased expenditure by the industry. ...Coupled with the high cost of generating and managing information inhouse, this rate of expenditure means that the industry spends very freely on information handling."* (Pickering, 1990) Drug information provision for health care personnel have been greatly enhanced during the 1980s. The national Drug Information (DI) network in NHS has played a very important role in it. There is also a responsibility for the industry to make drug information generally available. Most of UK pharmaceutical companies have a formal medical information service for external enquiries from health care professionals on their products. The regulatory system in the UK is one of the most comprehensive in the world. It is not only responsible for ensuring that medicines on sale are safe, effective and properly labelled, it also controls the investigation of NCEs and monitoring adverse drug reactions. These regulatory accomplishments have been achieved at high cost to the industry in terms of patent life erosion, expensive clinical trials, intensive documentation requirements and delay of regulatory procedure.

The industry information work plays a central role in the UK pharmaceutical information flow infrastructure. This is an industry led driven and oriented information flow.

9.3 Wider System: Pharmaceutical Industry in the Two Countries

CHINA

The main objectives of the Chinese pharmaceutical industry have been to meet the priority needs of the population through local production and to develop the country's export potential. Major problems encountered and the ongoing purposes have been related to the need to improve quality control over manufacturing, to increase R&D, and to strengthen international marketing capacity, especially in ethical drugs.

Today China is 90% self sufficient in drug supply. Currently China has an annual export capacity of some $600 million with a trade surplus of $200 million. Bulk pharmaceuticals and TCM constitute the whole volume of Chinese pharmaceutical exports. Although China is a major international supplier of pharmaceutical chemicals and TCM, its exports account for only 15% of the pharmaceutical industry's annual gross output and it has very little export business in ethical medicines.

Some 2000 pharmaceutical manufacturers produce 24 therapeutic categories of western medicines including 3500 finished products and 1300 bulk pharmaceuticals. Beside, they also produce some 4000 brand TCM products in 40 dosage forms. Since 1978, Chinese pharmaceutical industry has increased production at a rapid rate of average 10% per year. The Chinese population has benefited from the boom in the national pharmaceutical production and now has access to a much wider range of drugs including some quite sophisticated drugs.

The UK

The British pharmaceutical industry is one of the top seven in the world. It is an international industry with products that are results of extensive R&D, are patent protected and are available on prescription only. In terms of pharmaceutical R&D expenditure, UK accounts for 8% of the world; in the productivity of NCEs, UK accounts for 14% of the world; in prescription drugs sales world-wide, UK accounts for 31%. Beside, in 1989, Britain exported some £2 billion worth of pharmaceuticals (more than 6 times the Chinese export) with a trade surplus of nearly £1 billion. The UK has been maintaining its position as the third largest exporter in the world pharmaceutical trade through the 1980s. Because UK population accounts for only 1.2% of world population, the home market for UK pharmaceutical industry is too small. Since 1960, pharmaceutical export has been the major principal market for the UK pharmaceutical industry accounting for over 30% of its gross output each year on average.

Around 350 manufacturers from both international and national companies contributed to the record rise in pharmaceutical output which amounted to £6.3 billion in 1989. The pharmaceutical productivity has grown by 66% in real term between 1980 and 1989 which is three times greater than that of the UK manufacturing industry as a whole.

In the 1980s, the continuous growth in R&D investment with an average rate of 10% p.a. and in R&D employment with an average rate of 3.5% p.a. in UK pharmaceutical industry, have played an important part in maintaining the position of the UK pharmaceutical industry in the world.

The major problems encountered by the UK pharmaceutical industry include:

1. There has been an erosion of the effective patent life of British medicines which has been cut from 13 to 6 years over the past two decades. The erosion has been caused by the drug development and the regulatory delays which contributed to increase development times currently 12 years.

2. Under the pressure of intensifying and strengthening drug regulation world-wide since the 1960s, the pharmaceutical industry has to provide more information to the regulatory authorities, the health care profession and the public than they used to twenty or thirty years ago.

3. Many governments' cost saving measures squeeze the UK pharmaceutical industry to show a treatment is cost effective when compared to alternative treatments.

In conclusion, the pharmaceutical industry in the UK and China have the following objectives in common:

Objective 1. To make effective, safe, low-cost drugs available to meet the needs of the population (essential drugs);

Objective 2. To ensure that drugs are used rationally;

Objective 3. To develop, where economically and technically feasible, national pharmaceutical production that supports economic growth and the overall development strategy of the country.

However, UK has its strategical emphasis on objective 2 and objective 3; whereas China's strategical emphasis is on objective 1. With a population accounting for 1/5 of the world, China has the main objective to meet the priority needs of the population with a small pharmaceutical export which is only 15% of its industrial gross output and only 1/6 of the UK export volume; whereas with a population accounting for 1.2% of the world, the UK pharmaceutical industry gives export a very high priority. As the third largest exporter in the world, the UK pharmaceutical industry accounts for 31% of world-wide prescription drugs sales and over 30% of its gross output are for export for the past three decades.

The major problems and ongoing purposes for China pharmaceutical industry are to improve quality control over manufacturing, to increase R&D, to increase the number of NCEs approved in other countries, and thereby to strengthen international marketing capacity, especially in ethical drugs sales.

The major problems and ongoing purposes for UK pharmaceutical industry are to compete with more players in the world market, to restore the effective patent life to protect the industrial profitability, to safeguard the consumer interests by compelling regulatory authorities, by providing sufficient information to guide rational use of drugs, and by monitoring and reporting adverse drug reactions.

9.4 Purpose and Decision Taking of Pharmaceutical Information Work

In China, corresponding to the status of the wider system "national pharmaceutical industry" and the drug situation/pharmaceutical activity, the system S "pharmaceutical information flow" has one major mission - to support the S&T activities in the national pharmaceutical industry. Other information flows such as business information, drug information, statutory information and patent information are too small to be taken into account.

By comparison, the pharmaceutical information flow in UK has a broad system mission which includes:

1. To support the S&T activities in the national pharmaceutical industry,

2. To support the business of the pharmaceutical industry,

3. To provide drug information to the health care personnel and the public,

4. To provide information and documentation to meet requirements of the regulatory authorities,

5. To protect intellectual property and disclose S&T information by means of patents.

To achieve different system objectives, pharmaceutical information flow has been organized in the two countries accordingly.

Currently, the S&T library/information systems are being organized at the national level in China. Under the State S&T Committee, there is a national S&T information policy making body which is responsible for

1. Planning and co-ordinating the nationwide information sharing;

2. Planning and co-ordinating the national abstracting and indexing services;

3. Planning and co-ordinating the national computerized S&T databases.

At every ministry, there is a similar S&T information decision making body to advise on the above three issues to the ministerial leaders and to implement the plans within the ministry system throughout the country.

In China, there are about 50 national and ministerial S&T libraries and information centres, plus 350 provincial and regional S&T libraries or information centres.

In State Pharmaceutical Administration of China (SPAC), there is a S&T information system which includes 35 information services at administrative departments throughout the country. Furthermore, there are 57 research institutes in SPAC. Each of them has a S&T library or information service. The S&T information Institute at the SPAC headquarters is the central body for planning and co-ordinating information work among these information organizations.

In Ministry of Public Health (MPH), there are about 130 medical universities and colleges, in which there are 50 pharmaceutical faculties. In addition, there are over 400 research institutes in the MPH. Information work in the S&T libraries and information centres in these universities and institutes are planned and co-ordinated by the S&T Information Institute in Chinese Academy of Medical Sciences in Beijing.

In Academia Sinica, there are 27 research institutes in the life sciences and 15 in chemistry. Each institute has a S&T library or information service. The information work of the research institutes are under the plan and co-ordination of the Central Committee of Information and Publishing Work in Academia Sinica.

Compared to the information work in research institutes and universities, S&T libraries and information services in Chinese factories are relatively small in terms of resources and services. The information work in factories are mainly self contained without central planning and co-ordination.

In China, there is a national S&T publishing industry which now includes the publishing of about 3000 Chinese S&T journals and some 200 national abstracting and indexing journals with an annual volume of 1.5 million records (15% for domestic literature and 85% for foreign literature). The S&T publishing undertaking is under the management of Chinese Commission for Editing Translating and Publishing (CCEPT) in the State S&T Committee. There are about 60 domestic S&T bibliographic databases each with over 5000 records; plus several hundred small databases in building. These databases aim at provide computerized version of the two hundred Chinese abstracting and indexing journals. However there has been no central control over databases building so far.

Unlike in China, pharmaceutical information work in UK is not organized by central government but self organized within each professional area, excepting that the national drug information network has been well organized by the DHSS in the NHS.

In the UK, an industrial library/information system operates within its parent company which include S&T information, business information, drug information, drug registry and patent application related information work.

In the UK, a S&T library/information system operates within its parent organization with the comprehensive and effective back-up documents supply service provided by BLDSC. There are about 400 S&T libraries serving the total 220,000 S&T workers in the country.

In the UK, there is an internationalized information industry which includes traditional S&T publishing industry and online industry. This industry publishes about 4000 S&T journals; provides over 400 S&T abstracting and indexing services (both printed journals or online databases); including several of the largest international secondary databases in the world, such as INSPEC, CAB etc.. Information work in this sector is greatly market oriented.

In the world online market, business information contributes about 90% of the revenue, the remain revenue is from legal, S&T, news and other information. There is a boom in the UK business information industry. There are about 300 business information databases and 150 brokers in the UK market.

The UK pharmaceutical information flow has existed for a long time. Although it is led by the research based industry, there is no central decision taking process. On the other hand, the Chinese S&T information flow is very much under central government control. Under such a circumstance, we may expect the future Chinese pharmaceutical information flow to have a central decision taking process.

9.5 Performance of Scientific Information Flow in the Two Countries[13]

One may "measure" S&T information flow performance by studying user opinion on formal and informal channels, or indirectly by studying scientists' information disseminating and using ability. S&T information flow has been developed in China for

13 All statements and data in this section are summarized from Chapters 5 and 6.

40 years. Now we try to measure it in comparison with the UK S&T information flow.

9.5.1 Predominant Languages and Countries in the Field of Chemistry

Since the middle of this century, English language has become dominant in the field of Chemistry and especially biochemistry. English as the original language accounts for over 70% of total papers in CA. Nowadays USA, USSR, Japan, Germany and UK dominate the world chemistry literature (Mullen, 1990). UK contributes about **5.6%** of CA literature whereas China contributes about **3.5%** of CA literature. The CA only covers 10-15% of Chinese papers in the field. Moreover 98% of Chinese papers in CA are in the Chinese language.

The implication of the above figures is that foreign S&T information means information in foreign language to Chinese scientists, whereas for British scientists most foreign information are in English.

9.5.2 Small Impact of Chinese Scientists

Mainly because of language barriers, most Chinese papers have very small impact on scientific communication in the world. This in turn excludes Chinese scientists from the world communication circuit and means Chinese scientists can get little S&T information through informal channels from foreign scientists.

Compared to the leading position of UK, China has very small impact on world medicines research, which is reflected by

(1) Chinese eminent authors mainly have a greater impact on the Chinese scientific society rather than on the world scientific society. By comparison, British eminent scientists have major impact on the world scientific society.

(2) It is generally accepted that there is a "pecking order" of journals within any given subject area. In such a pecking order, Chinese scientific journals are ranked much lower than British and western journals; because Chinese journals receive much less citations and have less impact in the world than British and western journals.

(3) Although a significant proportion of British pharmaceutical scientists admitting the existence of foreign language barrier, up to 70% of them think all worthwhile work would be published in English.

By comparison, more than **90%** of Chinese scientists reported that they regard foreign language literature very important to their R&D activities. Moreover, 14% of them (those senior research scientists) confirmed that **they rely on foreign literature more than they rely on Chinese literature**.

(4) British scientists cite English language papers at more than 90% of total citations. Chinese scientists cite English language papers at 50-70% of total citations.

9.5.3 Scientists' Information Accessing Ability

In general it is perceived that **scientists in UK have higher information accessing ability than scientists in China.** The primary information need for obtaining documents which have been traced is far from satisfactory in China; comparing to the basic satisfactory situation in UK. The most serious problem is the foreign documents supply which is inadequate not only in middle sized and small cities but also in big cities such as Beijing and Shanghai.

British scientists generally enjoy better document supply service than Chinese. Although funds for academic libraries have been reduced in real terms and show signs of continuing to be reduced; interloan and national reference services can be called upon to help out in this event.

About 60% of Chinese scientists are not satisfied with the situation of documents supply by their institute library or existing library networks, because less than 75% of their information needs can not be met. Lack of satisfaction is reported by 50% of scientists in Beijing and Shanghai and by 80% of scientists in remote areas.

Under the circumstance of today's "information explosion", no single S&T library could claim to be comprehensive in collection. However, most of Chinese scientists have been restricted to very limited information collection and resource in their area, because of the poor communication and transport condition. Sharing of the national information resource is still far from reality in China, without a national or regional interloan system or documents supply system available.

9.5.4 Scientists' Information Searching Ability

(1) Generally, because the several large **world secondary publications** provide comprehensive coverage over chemistry and life science literature in the world, **both British and Chinese scientists have few problems in literature searching**. In China the national secondary publication system now produces

250,000 bibliographic records per year covering about 50% of Chinese literature. Generally Chinese scientists are satisfied with the situation in searching domestic literature.

However, there are differences in scientists' information searching ability between the two countries. The common features and differences are summarised as follows:

(2) Both British and Chinese scientists mainly rely on the traditional mean of **scanning journals** for current awareness - it is ranked first in the UK survey and Chinese survey. The effectiveness of such a searching activity would greatly depend on the journal collection in scientists' institution library and local S&T libraries.

(3) **SDI** service for current awareness is the second most used searching method by ICI chemical scientists. However, it is much less used by British academic chemical scientists and by Chinese scientists.

(4) That ICI chemists rely on SDI, inhouse patent bulletins more than academic chemical scientists reflects that there are **better information services in pharmaceutical industry** than in academic libraries, whereas UK academic scientists are still in favour of traditional ways such as personal contacts, reviews for current awareness which are greatly self supported. The nature of heavy market competition means UK pharmaceutical companies could not afford missing of information and delay in getting information.

(5) Both Chinese scientists and British academic scientists rank abstracts journal and review as frequently used methods. But British academic scientists show much more use of **colleagues recommending papers** than Chinese scientists. British rank review higher than abstracts journal whereas Chinese give the opposite rank.

(6) Compared to British industrial scientists, Chinese scientists rank abstracts journal and reviews relatively high in their index. British industrial scientists rank SDI, inhouse bulletins and colleagues recommending papers relatively high in their index.

(7) In China, each big research institute usually has a library and an information department. The latter is responsible for compiling **inhouse information bulletins**. This is similar to the situation in the UK pharmaceutical industry.

That ICI chemists rank inhouse bulletins at the 3rd of total 10 searching activities whereas Chinese scientists also reported certain use of such information service for current awareness.

(8) Unlike British scientists, Chinese scientists regarded **following up references** as less important. The explanation is that they face greater difficulty in getting access to and hold of most of relevant papers in the world.

(9) Chinese scientists quite firmly believe in **abstract journal** for timely and comprehensive information searching. They seem to be more confident in their ability in information searching than in obtaining literature (i.e. accessing the information).

(10) UK scientists do not regard **library catalogue and collection** as the major source for information searching. Instead, they search scientific literature mainly through secondary publications, computerized databases and informal communication. They do not have to worry about documents supply. They assume most of scientific literature which they have traced would be available either by local library or the national library document supply centre (BLDSC).

By comparison, Chinese scientists still regard library catalogue as major source for information searching. And they greatly rely on local libraries' collection, since there is no national or regional interloan systems available.

9.5.5 Informal Scientific Communication

During the 1960s and 1970s, some western researchers have brought the "invisible college" and "informal communication" to the attention of information studies (Price, 1963 & Garvey, 1972 & Meadows, 1974). Under the circumstance of "information explosion", an invisible college of magnitude 100 scientists can effectively solve a communication crisis by means of exchanging preprints and reprints, personal contacts and conferences etc.

Personal contact is a much less used information channel in China than in the UK, because the poor communication and transport facilities in China and the weak links between Chinese scientific community and the world scientific community. Because the language barrier and slim impact of Chinese research work or S&T literature on the world, Chinese scientists are still out of the "invisible colleges" at the world level. The informal communication between Chinese scientists and their foreign colleagues is at a relatively low level - most of Chinese scientists are going abroad to study whereas most of foreign scientists are coming to China for lecturing.

The conference is one of the first few channels for outside scientists to get aware of currently completed research work. In general British scientists are satisfied with the status of conferences as a communication channel. On average each British scientist attends 1-2 conferences per year.

There are not enough conferences for Chinese scientists. The conference is not a frequently used information channel for current awareness in China. On average each Chinese S&T worker attends conference every 7 year. The great importance of foreign S&T information to Chinese R&D and the fact that generally Chinese scientists are outside "invisible colleges" at world level have made *international conference* one of the most valuable information source for Chinese scientists. However each year, only 1% of Chinese pharmaceutical scientists could attend international conferences in China and only 0.01% of Chinese pharmaceutical scientists have chance to attend international conferences abroad.

9.5.6 Enhanced Searching Ability by Online

It is clear, in the early 1980s British industrial scientists relied on online searching much more than their academic counterparts. In 1981, online was ranked the second by ICI scientists but the 4th by Oxford scientists. During the period of the 1980s, online services have been widely spread in the whole research community in the UK.

By 1988, 100% of UK university libraries offer online searching services. Of them, 75% reported annual number of searches has risen during last two years. However, British academic scientists still use online less frequently (9th rank) than industrial scientists (3rd rank).

By the end of the 1980s, IT application has been further improved in UK industrial R&D sector. About 56% of UK chemical companies have started end user searching in 1988. In 1988, the online volume in a middle sized pharmaceutical company, such as Pfizer UK is ten times the average figure in a UK academic or public library.

Computerized information technology (or IT) was introduced into China only in the early 1980s, it has been mainly concentrated in the big cities.

By the end of 1986, 60 online searching terminals connecting with European and North American hosts have been established in 27 big cities of China. The biggest international online searching centre is at ISTIC headquarters in Beijing with an annual volume of online searching of $34,600 in 1986 accounting for 15% of the British Library SRIS online expenditure in 1986/87. In 1988, China conducted some 20,000 international online searches accounting for 0.1% of the world figure and being only 4 times the online volume in a large UK pharmaceutical company Glaxo. The average online volume in the 60 Chinese online searching centres is 2-300 searches per year, which is similar to that in a large British academic library. The current status of online searching in China is similar to that in Europe in the early 1970s.

Generally, both British and Chinese scientists are satisfied with online searching results. However Chinese scientists do not satisfied with the subsequent documents supply service. About 17% of journal papers, 73% of conference papers, 45% of reports and 100% of theses hit are not available in China.

9.5.7 Information Disseminating Ability

Chinese **scientists' information disseminating ability** is quite a lot lower than British scientists.

Assuming only senior Chinese scientists as potential authors then the average publication rate is one paper per scientist per year in China; comparing to 2-3 papers per academic staff per year in UK universities;

The conservative estimate is that a Chinese scientist's annual publication capacity is one third that of a British scientist. The lower productivity by Chinese scientist may have been resulted from the lower S&T journal capacity in disseminating the nation's R&D results in China sthan in the UK.

Because the predominant position of English language in world scientific literature and the leading position of medicines research by British scientists for several decades, it is safe to say that all journal papers by British scientists are disseminated in the world communication circuit.

However, it must be noted that 4% of Chinese papers in world journals and 10% of Chinese papers in world secondary publications do not indicate that only such proportion of Chinese literature are at the same academic level as all British journal papers. It only indicate that **Chinese scientists have a much smaller capacity in disseminating information** to the world than British scientists.

9.5.8 Information Productivity

A standard of "**eminence**" requires an eminent Chinese scientist having published **3-4 non-Chinese papers** in world journals each year. Under such a standard, it is estimated that there are several hundred of such Chinese scientists currently. They account for **0.01%** of 400,000 Chinese scientific authors or **0.0005%** of total 7.8 million S&T workers in China.

The most prestigious of the UK learned societies is the Royal Society with 1000 fellows currently. Those scientists elected Fellows of the Royal Society (FRS) are regarded as the most eminent scientists in the UK. They account for **0.4%** of total 220,000 S&T workers in the UK. The average productivity for a FRS is **3 papers** per year in a life time.

9.5.9 Information Using Ability

Chinese scientists **information using ability** is lower than British scientists as evidenced from the following points:

(1) That Chinese clinical pharmacological scientists show more **diffuse information use** (over subject width) than their British colleagues partly because the premature status of the clinical pharmacology in China.

A nation's scientists' information using ability may be influenced by the academic level or the status of research in the subject field in the country. Lower academic level and premature research status may result in diffuse information using by Chinese scientists.

(2) Chinese scientists cite fewer papers in their work than western scientists.
The **average citation rate** in Chinese S&T journals is 5.4 citations per paper comparing to 20.8 in the world journals covered in SCI. Another example is that CJCP has an average citation rate of 8.6 whereas BJCP has a rate of 18.2. The reasons for less citations by Chinese papers are complex. One possible influence may be the lower information accessing ability of Chinese scientists than that of British scientists.

(3) Chinese scientists have to use more than 50% of literature in foreign language whereas British scientist use over 90% of literature in their native language. This agrees with the user study result that Chinese senior scientists reported **relying on** foreign language literature more than on Chinese literature. Greatly relying on foreign language literature means great difficulty in using information by Chinese scientists.

9.5.10 Literature Aging

Generally, **fast aging results from focused use by the more effective information processing** while slow aging results from diffuse use by less effective information processing.

Aging analyses indicate:

(1) Chinese scientists can use and absorb Chinese information more effectively than they use and absorb foreign information.

(2) The eminent Chinese scientists represent the centre of information processing or using in the subject field. They use and absorb S&T information especially foreign language information more effectively than ordinary Chinese scientists.

(3) Compared to Chinese scientists, British scientists use wider time span of scientific literature, they cite more papers in their work, they "age" literature faster. All these may reflect that compared with Chinese scientists, **British scientists are more effective in using information.**

If we perceive that the scientific information flow in Britain and United States is characterised by learned journal, "invisible college", conference and IT, in China the specific feature of scientific information flow is the two circuits of scientific communication - foreign (language) information communication and Chinese (language) information communication.

At the foreign communication circuit, there are very few eminent Chinese scientists - only 1% of Chinese scientists publish papers in foreign languages and have chance to attend international conferences; about 0.01% of Chinese scientists publish 3 papers in foreign journals per year and attend conferences abroad. These eminent Chinese scientists represent the effective information using and processing core. Mainly the following three factors contribute to the existence of *two circuit communication*: 1. Language barrier, 2. Premature status of R&D in the country, 3. Limited information resources in the country. Some eminent Chinese scientists become active in foreign communication circuit by studying and working abroad to avoid the above three communication obstacles.

9.6 Pharmaceutical Information Resources in China and UK

9.6.1 Limited S&T Information Resources

9.6.1.1 Primary Literature Publishing Capacity

Generally, a Chinese scientific **journal** has a smaller **capacity in disseminating the nation's R&D results** than a British scientific journal. Evidence for this includes

(1). there are not enough journals in which Chinese scientists can publish their work; China has a S&T manpower of 7.8 million which is 35 times the UK figure whereas the number of S&T journals in China is about 3/4 of the figure in UK;

(2). the average refereeing and editing time for submitted journal paper in China is 18-24 months which is 1.5-2 times the UK figure;

(3). assuming only senior Chinese scientists as potential authors then the average publication rate is **one** paper per scientist per year in China; comparing to 2-3 papers per academic staff per year in UK universities;

(4). the average number of papers per journal per year in China is 100 comparing to 171 in the UK.

9.6.1.2 Abstracting and Indexing Services

During the 1980s, the UK secondary services community was continuing to develop in response to demands from the marketplace, both in terms of producing new services and in increasing the availability of services online. There were **430** UK secondary services available in 1986 which represented an 11% increase since 1983. 46% of services in 1986 could be accessed online, compared with just 31% in 1983. The number of online bibliographic databases comprising these services almost doubled over the same period- from 50 in 1983 to 93 in 1986. The UK abstracting and indexing services produce about **3 million** bibliographic references annually.

In pharmaceutical areas, the three major services based in USA - CA, IM and BA use British organizations to abstract and index the British published literature. The large international secondary publications and databases could cover most of UK scientific literature.

Under the supervision of the China Commission for Editing, Translating and Publishing S&T Documents (CCETP), the build up of the national secondary publication system has been completed with 229 abstracting and indexing serial (158 reporting foreign information and 71 reporting domestic information) and an annual production of 1,370,000 records (1,170,000 foreign records and 300,000 Chinese records) by 1987.

The number of secondary services and the number of bibliographical records in China are 50% of the UK figures respectively.

However, there has been rapid growth in the Chinese secondary services. From 1981 to 1987, there has been an increase of 70% in secondary publication in titles and in records compared to the 11% increase in UK during 1983-1986.

The production of foreign secondary publication has engaged 90% of funds and manpower in the Chinese secondary publication system. The time span between a foreign journal paper being published and its bibliographic record appearing in Chinese abstracts and indexes journals is quite long, in some cases being over 20 months or 5 times the time lag in international secondary publications.

Generally, the Chinese national S&T secondary publication system could cover most of high standard domestic S&T literature. However, the comprehensiveness in coverage of the national system is questionable. An estimate is that about 50% of Chinese S&T literature in medical science are covered by the national S&T secondary publication system.

By 1989 there are only 61 bibliographical databases with over 5,000 records in China (none of them are accessible online); comparing to 93 online databases and many more non-online databases in UK in 1986.

Although China has been left behind in computerized bibliographical database building, its printed secondary journal system has been well constructed and have a capacity of producing 300,000 domestic records covering most of high standard S&T papers in the country.

9.6.1.3 S&T Library and Information System

(1) Different Acquisition Policy in the Two Countries

In UK, most S&T libraries and information services (excepting BLDSC) concentrate in collecting S&T literature in English language. The BLDSC serial acquisition policy reflects a continuing effort to collect serial in all subjects from all over the world and in the vast majority of languages. Now it has an annual intake of 55,000 titles. The policy for monographs is to try to obtain all serious and research level monographic items in English where-ever published. Now the annual intake of monographs is 40,000 volumes, plus 155,000 reports and 10,000 US and UK doctoral theses.

China spends up to 90% of acquisition budget in collecting foreign (language) literature to cover most important S&T literature in the world. Every year, China imported about 70,000 titles of foreign academic books and 16,000-19,000 titles of foreign journals. The former is **1.75 times** the BLDSC acquisition whereas the latter is **one third** of the BLDSC acquisition.

(2) S&T literature collection is not comprehensive at national S&T libraries and information centres in China.

About five national S&T libraries or information centres concentrate in Beijing and Shanghai with current foreign journal collection ranging from 3,000 to 7,000; plus about 3,000 Chinese S&T journals. The biggest current journal collection is in the National Library of China accounting for 1/7 of BLDSC collection. The Chinese national libraries mainly function as central S&T reference libraries like SRIS in London. None of the Chinese national S&T libraries provides a documents supply service like the BLDSC.

(3) General limited information resources in S&T libraries and great differences among institutions and among areas in China.

(i) In Britain,

Research based pharmaceutical companies have spent "freely" in information work compared with the financial constraints in academic libraries. In the contrary, most of large S&T libraries and information services are concentrated in government research institutes and universities. The S&T library or information service in a large Chinese factory is at the same level of a small government research institute.

(ii) In China,

Large research institute library (15% of total libraries) normally has 500-3,000 current foreign journals and a similar number of Chinese journals;

Middle sized research institute library (25% of total libraries) normally has 50-500 current foreign journals and similar number of Chinese journals;

Small research institute library (60% of total libraries) normally has less than 50 current foreign journals and a few hundred Chinese journals; about 80% of S&T libraries in administrative departments, and 90% in factory R&D divisions are at this level.

In Britain,

Large academic library (10% of total libraries) normally has over 10,000 current journals;

Middle sized academic library (25% of total) normally has 5,000-10,000 current journals;

Small academic library (60% of total) normally has 1,000-5,000 current journals; large pharmaceutical company library in Glaxo, ICI etc. having a similar magnitude of current journal collection.

The top 15% of Chinese libraries have a magnitude of current journal collection similar to the middle 25% of UK libraries. The middle 25% of Chinese libraries have a magnitude of current journal collection similar to the bottom 60% of UK libraries. About 60% of Chinese research institute libraries, 80% of S&T libraries in administrative departments, and 90% of S&T libraries in factory R&D divisions have very limited information resources.

(iii) In China more than half of imported S&T information is concentrated in Beijing, while most of the remaining part is held by less than ten biggest cities. However, there is no central documents supply scheme in China. Consequently, about 50% of scientists in Beijing and Shanghai are not satisfied with documents supply with the unsatisfactory rate being up to 80% of scientists in other cities.

(4) Worldwide Inflation of S&T Literature and Impact on British and Chinese S&T Libraries

For the past ten years, there has been a rapid escalation in journal price. The UK university pay and price index - a conservative calculation - gave a value of **235.6%** increase. Most of UK academic libraries have reduced their acquisition for the past two decades.

In China the inflation of S&T literature price for the past five years, are contributed by two factors: world-wide literature price inflation and rapid inflation at home. In the Library of Academia Sinica, the average foreign journal price has grown from ¥361 in 1985 to ¥1551 in 1989 - increasing by **329%** during five years. Although annual foreign journal expenditure has grown at an average rate of 16% p.a., the annual intake of foreign journals has decreased at a faster rate of 27% p.a.. The foreign journal price inflation rate is about 30% p.a in China.

In the Library of Academia Sinica in Beijing, from 1985 to 1989, the number of foreign journals have been reduced by 50%. The National Library subscription has declined from 13,693 in 1987 to 7741 in 1990 (decrease by 50%). The ISTIC Beijing centre reduced its foreign journals from 5408 in 1988 to 4200 in 1990 (decrease by 20%). The ISTIC Chongqing centre reduced foreign journals from 7000 in 1987 to 1348 in 1990 (decrease by 80%).

(5) The current S&T information system in UK is characterised by its central documents supply service (BLDSC) and wide spread IT application.

(6) The current S&T information system in China is characterised by its dual price system for domestic and foreign information (in 1989, the average Chinese journal price is ¥15 whereas foreign journal price is ¥1,500); up to 90% of acquisition expenditure in foreign information; and great emphasis in foreign information work. About 90% of bibliographic records produced in Chinese abstracting and indexing journals are foreign records. The *foreign information analysis and research* is a major information work in almost all S&T libraries and information services which is estimated engaging nearly 20% of information staff.

9.6.2 Other Pharmaceutical Information Resources

9.6.2.1 Business information for pharmaceutical industry

In UK, there has been a boom in business information industry during the 1980s, partly owing to the increased demands and partly owing to the wide spread IT application. Business information companies are amongst the stars of the UK stock market. In the world as well as in the European online market, business information accounts for more than 90% of the total revenue. The world largest pharmaceutical business information company IMS (mainly covering European, North American and Japanese information) makes its income up to $400 million per year.

In China, the economic reform started since 1979, has given rise to industrial demands for business information. By the late 1980s, some business information services have been set up on the basis of previous S&T information organizations. The nature of profit making in business information has been found. Within the SPAC S&T information system, there are three such business information services each with over ¥100,000 income per year.

There are hundreds of business information databases, brokers and thousands of business consultants in the UK. Having benefited from the convenience of advanced communication network and information technology, they provide a great variety of services with high speed and quality. Comparatively, there are very few business information services in China. Furthermore, these Chinese information services still greatly rely on the traditional and manual means to disseminate information, such as compiling information bulletins.

In the UK, business information work has been developed to cover very detailed information ranging from company reports, sales statistics, medical statistics, products information, R&D monitoring etc. The existing Chinese business information systems mainly provide directory of enterprises and market information.

Above all, the market economy is still in an early stage in China. The business information needs are not well recognized there. The mechanism of business information flow is far from sophisticated. The market for business information has not been set up yet.

9.6.2.2 Drug information for doctors

In Britain, needs of doctors for new drug information can be met by means of promotional literature in scholarly or professional journals, postal advertisements and representatives from pharmaceutical companies. Chinese pharmaceutical factories disseminate new drug information similarly to the UK companies. The major difference is that new drug promotion is aimed at doctors directly in the UK, while it is not directly aimed at doctors but at hospital pharmacists in China. In other words, Chinese doctors mainly rely on pharmacists for new drug information.

The problems which occur to doctors are similar in the UK and China, including *administration/dosage, adverse effects/toxicology, availability/supply, clinical use, identification, interaction, pharmacology and pharmaceutical problems*. The difference lies where doctors try to find information.

In Britain, hospital pharmacies, area drug information centres and regional drug information centres constitute the national drug information network. To supplement the network, the pharmaceutical industry provides product information to doctors and health professionals. Furthermore other professional associations such as Royal Pharmaceutical Society also provide drug information services.

Each year, a regional centre handles more than one thousand enquiries; the area centres in a region handles about 65,000 enquiries; a pharmaceutical company handles about three thousand enquiries; the Royal Pharmaceutical Society handles about 16,000 enquiries nationwide.

By comparison, the provision of drug information for health workers is semi-organized in China. There are no formal information services in the Chinese national health care system. The majority of Chinese pharmaceutical factories do not provide medical information services to external enquiries. It is also reported that Chinese doctors rarely use industry information source.

Table 7.4 and Table 8.6 compare the information sources used by British doctors and by Chinese doctors.

British doctors mainly use hospital pharmacy or area information centres for the four categories of information (in order of usage):

(1) clinical use, (2) administration/dosage (3) pharmaceutical problems (4) availability/supply;

British doctors mainly use regional Drug Information (DI) centre for the four categories of information (in order of usage):

(1) clinical use, (2) adverse effects/toxicology, (3) pharmaceutical problem, (4) administration/dosage.

Chinese doctors mainly rely on hospital pharmacists for the following information (in order of usage):

(1) availability/supply, (2) pharmaceutical problem, (3) identification, (4) administration/ dosage.

Chinese doctors mainly rely on their own knowledge or read professional journals for the following problems (in order of usage):

(1) interaction (2) clinical use (3) adverse effects/toxicology (4) pharmacology and (5) administration/dosage.

The main difference in using drug information sources is that Chinese doctors still greatly rely on themselves for information such as *drug clinical use, adverse effects/toxicology;* while their British counterparts could use existing hospital drug information service and national DI network for more efficient information searching.

9.6.2.3 Medicine regulatory system and statutory information flow

Generally, there are similar medicine legislation systems in the UK and China. The Chinese system is established in 1985 which is 22 years later than USA and 17 years later than UK.

The US and UK regulatory systems divide clinical trials into 4 phases and require **one-two thousand patients** during phase I-III; and more clinical evaluations during Phase IV post market surveillance. Such studies (Phase I-IV) can take anywhere between **3 and 5 years.**

The Chinese regulatory system divides clinical trials into 3 phases and requires **three hundred patients** during phase I-II; and more clinical evaluations during phase III which normally takes **2 years.**

In general, regulatory requirements for new drug application are more complex and restrictive in UK and US than that in China. The standards and information requirements for new drug application are still quite simple, especially in the case of TCM.

The information requirement for TCM new drug, unlike that for WM, does not include product chemical name, compound chemical structure. Chemistry of the drug substance is the major omission.

Only TCM ingredients are required, though there are also the problem of standardization in ingredients. Also the pharmacological studies and clinical trials are less sophisticated in TCM than in WM.

Since 1964, the UK has been relying on the yellow card system for spontaneous reporting by prescribers to public in the first case and to CSM in the second case on adverse drug reaction (ADR). About 14 years late, in 1988 China started establishing a national postmarket surveillance system based on 10 large hospitals.

In the West, preparation of new drug registration documents has been proved to be a cause of intensive information work in a pharmaceutical company. It results in the creation of hundreds of volumes of documents. However this kind of information work is not well organized by pharmaceutical factories and medicines research institutes in China.

9.6.2.4 Pharmaceutical patent system and patent information flow

Since the 1960s, most of the developed countries have introduced pharmaceutical products patents. The function of a patent is primarily to stimulate inventive activity by preventing a new product from being imitated during a legally sanctioned period of 20 years from the date of application (WHO, 1988).

From 1963 to 1988, the number of world pharmaceutical patents has steadily increased by over 200%. More significantly, the growth of UK pharmaceutical patents has been much faster than that of world pharmaceutical patents. During the period of 1963-1988, the UK pharmaceutical patents has increased by over 600%. For the same period, the percentage of UK pharmaceutical patents as the total pharmaceutical patents granted in US has grown from 3.6% to 6.4%. The figures indicate that the steady growth in UK pharmaceutical R&D activity through the past three decades.

China only established its patent system in 1985. So far there has been no patent protection for pharmaceuticals. Furthermore the number of Chinese pharmaceutical patents being granted abroad is estimated to be very small.

The trends in the pharmaceutical patent system in the near future include:

firstly, in the UK and other developed countries there will be a restoration of effective patent life from currently 6 years to previous 13 years; secondly, in China there will be an expansion of patent life from 15 years to 20 years and the inclusion of pharmaceutical patent protection.

There are similar great demands for patent information in UK and China. Both countries have built up national patent information service network.

The SRIS of British Library has an annual intake of over **one million world patents** and has long provided a comprehensive service to UK users which is supplemented by a national patent information network of about twenty local patent libraries/information centres. It is reported that the number of readers and remote enquiries for the patent information network (not including SRIS) is about

19,000 per year. At SRIS about one third of the 150,000 readers visits made each year patent enquiries. Additionally, there are 19,000 telephone patent enquiries per year.

The Patent Documents Library (PDL) in Chinese Patent Office has an annual intake of about **one million world patents.** Each year PDL receives about 45,000 readers from all over the country. The 62 local patent documentation services are mostly set up in 1985. Their main function is to disseminate patent documents published by Chinese Patent Office. The use of the 62 services are relatively small at present - about 24,000 readers each year.

Apart from PDL in Beijing, there are other 34 patent documentation libraries - ten in the government ministries in Beijing and 24 in provinces. The 34 patent libraries have certain amount of foreign patent collections. Except Chongqing Centre of ISTIC and Zhejiang Province, other patent libraries have collection much less than PDL in the Chinese Patent Office in Beijing. Like other kinds of imported information materials, foreign patents are concentrated in a few of the biggest cities such as Beijing, Shanghai, Chongqing. The major problem remains the patent documents supply and resource sharing in China.

9.7 Relationships Among Five Information Flows (the UK model)

Pharmaceutical information flow is composed of scientific information, business information, drug information, statutory information and patent information. However, it is not the simple sum of the five information flows. The five information flows are, on one hand, different in terms of the function, the nature, and the status. On the other hand, they are associated with each other in some ways, and all connected with the pharmaceutical industry.

9.7.1 Overlap Relation

The overlap relation is quite straight forward and clear. There are many overlaps among the five information flows, such as

1. Scientific information and patent information. It has been well recognized that patent information is one kind of important S&T information sources.

Under today's highly competitive circumstances, most of pharmaceutical innovations made in the developed countries apply for patent protection in the first place and then disseminate to the scientific community. Because patents involve disclosure, new ideas are made available to others and thus competition is encouraged.

2. *Scientific information and business information.* One example of such overlap is *biotechnology information.*

Apart from chemical synthesis, there are other sources for the generation of new drugs. Medicine has always depended on natural products. Today extensive research is being conducted to identify, isolate and synthesize pharmacologically active substances from natural sources. Biotechnology is an interdisciplinary subject which became popular in the mid 1970s; and known as "the application of biological organisms, systems or processes to manufacturing and service industry" (Crafts-Lighty, 1990).

It is difficult to distinguish the boundaries of biotechnology but most people tend to associate it with its commercial or practical applications. Relevant materials are widely dispersed and can be drawn from the fields of medicine, biochemistry, genetics, microbiology, immunology, chemical engineering, chemistry and computing.

In the 1980s, about 40 newsletters monitoring the biotechnology industry have been started in the world. Additionally there are certain number of research journals specialised in the field. The proliferation of newsletters and their research oriented counterparts has also led to a market for abstracting services in biotechnology. Crafts-Lighty has listed 4 specialised online databases: *Abstracts in BioCommerce* (BioCommerce Data), *Biobusiness* (BIOSIS), *Biotechnology Abstracts* (Derwent Publications) and *Current Biotechnology Abstracts* (Royal Society of Chemistry) (Crafts-Lighty, 1990).

3. *Scientific information and drug information.* Drug information is mainly provided to doctors and health care personnel for rational use of drugs, and is also an important kind of S&T information for pharmaceutical R&D.

4. *Scientific information and statutory information.*

The legislation requires the manufacturer of the product to obtain a marketing authorization for each product. This is granted after some expert group is satisfied with the specifications of the product and the biological and clinical tests that have been performed with it. The regulatory requirements (statutory information requirements) will determine the R&D procedure and the scientific information generating during the R&D procedure.

One example of such overlap is the *technical development information*.

Technical development is further divided into *process development, analytical development, formulation development and production*. A significant proportion of S&T information in development phase is overlapped with statutory information.

The process development scientists need information on alternative methods of preparation of chemical entities whether by chemical or by biotechnical methods; need information on compounds or similar structure. They also need to know whether the projected starting materials are likely to be available in the required quantities and whether they have been registered under hazardous substance legislation. Information on reactions and conditions for optimum yields is also needed.

Analytical procedures must be developed for all ingredients in the formulation. Specifications for all significant ingredients must include confirmation of their identity, quality and significant impurities with criteria for acceptance of batches. The formulation development must make sure that the formulation is stable, safe, reproducible, free form contamination. The formulation of a medicine is designed to make available to the patient the correct quantity of drug at the correct rate in a stable, safe and acceptable form.

The most important requirement for an information centre serving development and production functions is an up to date set of **pharmacopoeia.** Pharmacopoeia comprise monographs specifying the assay, impurity levels, ranges of significant physical parameters and other properties of drugs available in the country of publication. If the drug meets the standards laid down it is then considered to be of suitable quality to be marketed in that country.

5. *Business information and drug information.* One important kind of business information - product information is greatly overlapped with drug information.

6. *Business information and patent information.* One important function of business information is the monitoring of R&D activities. Patents constituting an important source of current S&T information could serve this function.

7. *Business information and statutory information.* Information on the political environment within a country is important in terms of business prospects in that country. The political environment can have an impact on pricing policies, returns on investments and marketing for multinational corporations, legal requirements for product licenses, patent protection, etc. For the UK pharmaceutical industry, the main customer is the NHS, i.e. the government- hence customer information is very much tied up with policy and social issue.

8. *Drug information and statutory information.* Under the Yellow Card system in UK doctors report ADRs to the Committee on Safety of Medicines (CSM). The regulatory authority is the central figure in this drug information gathering.

9.7.2 Interactive Relation

The best example showing the interactive relation among the five information flows is the existence of ***pharmaceutical information specialists*** in the commercial environment or the information industry like *IMS*, *PJB* etc..

PJB is a UK based pharmaceutical business information company first funded in the mid 1970s. Today it has about 130 staff and annual turnover of over 9 million pound (1990). In response to the increasing information demands from the pharmaceutical industry, PJB has experienced a stable growth since its foundation which is particularly remarkable during the recent economic recession in the UK. PJB publishes a range of international business newsletters, annuals and special reports for senior executives in the pharmaceutical areas world-wide. Its information products have a very broad coverage both **in subjects**, including R&D projects and progress, manufacturers and products, regulatory and legislation, financial analysis and statistics, situation of disease, health care and market; and **in countries** mainly focusing on USA, Japan, and European countries, also including developing countries to certain extent.

The other example of such an interactive relation among the five information flows may be found in ***the internal information databases management and use*** in a large research based pharmaceutical company. During the R&D process, the proprietary databases (containing **S&T information**) need to be maintained in a form which will meet legislation requirements for patent application (becoming **patent information** later) and Clinical Trial Certificate application. During clinical trials, the company must hold the information in a form suitable and ready for compiling regulatory submissions (work involving **statutory information**). The company also needs a post market surveillance database to collect and store information on the world-wide experience with its products (**drug information**). Furthermore, the company may use such internal databases for training of sales representatives; approval of product advertisements, labelling, and press releases; preparation of prescribing information documents etc. (i.e. **business information** work relating with marketing).

9.7.3 Effects of Interaction and Connective among Information Flows

In the UK, *pharmaceutical information* has already been treated a special category of information activity. The interaction and connective among S&T information, business information, drug information, patent information and statutory information have been recognized. One effect of these is ***the existence of pharmaceutical information as a profession*** both in practice and in academic field.

The pharmaceutical industry has already successfully *united* scientific information work, business information work, drug information work, statutory information work and patent information work together under its general system goals. Because of the great information demands of the pharmaceutical industry, there has been a booming in the pharmaceutical information business in the UK as well as in other industrial western countries. Such a business may have millions US dollars of turnover each year (see Chapter 7).

In academic area, there are *pharmaceutical information studies* including scientific information divided by subjects such as chemical, biological, biotechnology, bio-medical, toxicologic, technical development and clinical trials; business information; patent system; legal and regulatory system; pharmaceutical company information work; drug information and post market surveillance (Pickering, 1990). Some British universities have been providing postgraduate courses on pharmaceutical information and undertaking information retrieval (IR) projects for/with the pharmaceutical industry for quite long time (Wilson, 1990).

9.8 Pharmaceutical Information Flow and Environments

In a country, pharmaceutical information flow exists within its special environment "drug situation/pharmaceutical activity" and its general information/communication environment. Naturally there are influences and counter influences between the system "information flow" and the environments. Although it is impossible to measure these influences by any scientific methods, a descriptive study of them still is necessary to complete the whole picture of comparison.

9.8.1 Influences from Environments on Pharmaceutical Information Flow

The influences from environments on pharmaceutical information flow system S are simplified in Figure 9.2.

Firstly we look at *"drug situation* or *pharmaceutical activity"* in UK and China to find out its influences on *pharmaceutical information flow* in the two countries.

British people belong to 25% of the world population in developed countries who consume 79% of the world drug. Generally, the NHS could provide modern health care to the population in UK. There is a well organized national drug information network in NHS on a par with the medical information services provided by the industry.

By comparison, Chinese people belong to 75% of the world population in the third world consuming only 21% of the world drug. China is 90% self sufficient in drug consumption. However mainly the urban population (20% of total) has regular access to modern health care (i.e. hospitals, sophisticated drugs etc.) There is a semi-organized drug information provision to health workers. The low level of drug consumption may be the major cause for the very limited drug information flow.

The UK pharmaceutical industry is the third largest exporter in the world. The export capacity of Chinese pharmaceutical industry is only 12.5% of the British one. Consequently there is a big business information flow in UK while business information is quite small in China.

The UK pharmaceutical industry is characterized by multinational R&D companies, highly patented products, high investment in R&D, high risk and high profit. There is a highly sophisticated information flow within the industry. The UK industry plays a leading role in pharmaceutical information flow.

By comparison, Chinese pharmaceutical industry is mainly the manufacturing type of industry with very limited R&D activity. Although drug R&D has progressed significantly in research and academic institutions, there are problems in how to bridge research activity with industrial development and production. Generally there is a weak information work in Chinese pharmaceutical industry.

Britain among other 5-6 countries has been leading the world medicines research for several decades. China, on the other hand, has thousands of years experience in using TCM and has a very rich resource of TCM herbs to rely on for new drug R&D. Since 1949, significant progress has been made in applying the western S&T to TCM and WM research in China. However, China is still being left behind in pharmaceutical R&D by the UK and other few developed countries. Few Chinese NCEs are recognized by the world while the UK accounts for 14% of the world NCEs.

The UK leading position in medicines research in the world has brought many benefits to scientific communication in the country - most of British scientific papers are covered by large international abstracting journals or databases, more British scientific journals have high reputation in the world, many British scientists have a world-wide impact. By comparison, most of Chinese scientists are out of the world-wide scientific communication system. Only 1% of them could publish papers in non-Chinese language journals, only 0.01% of them publish 3 papers in non-Chinese journals each year which equals to the average productivity and dissemination capacity of a British scientist. Apart from the language factor, the relatively low level of medicines research may have obstructed communication between Chinese scientists and foreign scientists.

It is easy to understand how the pharmaceutical patent system and the drug regulation system have brought in patent information flow and statutory information flow in the UK. It may not be so easy to explain how the backwardness in patent and regulation systems would influence pharmaceutical information flow in China. Generally such weak patent and regulation systems could make Chinese pharmaceuticals (especially NCEs) less competitive in the world. Sequentially, Chinese pharmaceutical industry will have little share of the world market and bring in little hard currency for further R&D investment.

Secondly, we look at how the *world-wide growth of science* affect scientific communication and S&T information flow.

For a developing country like China, the government R&D expenditure could not keep a rapid growth. The two major problems are how to cope with the world literature proliferation and world literature price inflation and how to increase its scientific journal and abstracting journal capacity of disseminating the nation's R&D results. For the scientists in the developed countries like UK, there is another kind of problem: whether it is safe to ignore the great amount of non-English S&T information existing in the world? If not, how to cope with this extra "information explosion"? As China is emerging as a big scientific nation, the pattern of formal and informal scientific communication in the world will gradually change.

Despite of the overall stagnation in R&D employment in the UK in the 1980s, UK pharmaceutical industry has maintained a growth in R&D manpower at 3.5% p.a. and has risen R&D proportion in its whole labour force from 15% in 1980 to 23% in 1989. Meanwhile the UK pharmaceutical industry R&D expenditure has grown at 10% p.a. comparing to 2.9% p.a. in the whole UK R&D expenditure. During 1963-1988, the UK pharmaceutical patents have increased by over 6 times. All these have stimulated the growth of pharmaceutical information flow in this country.

Thirdly, we look at influences from general *communication environment.*

The relatively low capability of transportation and communication in China, especially the 20 year lag in IT application between China and UK, has greatly obstructed the ever growing scientific information flow. By comparison, in the advanced western countries including UK, there has been a great enhancement in communication environment. The IT which firstly grew from scientific information field, has now made its largest application in business information industry. The relatively big investment in IT by the UK pharmaceutical industry has brought it an "information rich" environment.

9.8.2 Influences on Environments from Pharmaceutical Information Flow

Against the influences from environments, pharmaceutical information flow system S makes counter affects to its environments in some ways.

The *medicines research status* in a country would be enhanced if the scientific communication is significantly improved. If the whole pharmaceutical information flow, especially business information flow are strengthened, it may promote the national pharmaceutical industry especially in the R&D based sector, and therefore resulting in a greater investment in R&D by the pharmaceutical industry, according to the examples in UK pharmaceutical industry and in other western countries.

There is little doubt that increased scientific communication would result in the *growth of science* in the society. The UK pharmaceutical industry is well known by its great commitment in information work. This has consequently resulted in the high productivity of R&D activities. During the 1963-1988, in contrast the decreasing trend of the whole UK patent as a proportion of world patent (4.1% in 1963 to 3.4% in 1988); the UK pharmaceutical patent as a proportion of world pharmaceutical patent has increased from 3.6% in 1963 to 6.4% in 1988. Similarly, the great growth in Chinese scientific literature during the 1980s, has mostly benefited from the improvement in national S&T information system during that period.

The *communication or information environment* in a country will be enhanced in terms of its resources, its capability, the demands for it, and utilization of it; if its beneficial effects are well recognized by the society.

The great IT commitment by the UK pharmaceutical industry and the fact that 90% of world online revenue is from business information reflect that the enhancement of communication environment and the prospects of information industry rely on the market demand which in turn is influenced by the beneficial effects of the current information flow system.

9.9 A Future Pharmaceutical Information Flow System in China

9.9.1 Necessity to Reform

In Table 9.2 we summarize some major differences in current pharmaceutical information flows in the two countries.

The drug situation peculiar to China includes a national policy for domestic manufacturers to supply 90% of the domestic market, a manufacturing type of industry with little R&D investment, limited export confined to bulk pharmaceuticals and TCM raw materials, no share of the world ethical drug market, a less sophisticated legislation system and no pharmaceutical patent protection. Under such situation, pharmaceutical information flow is dominated by S&T information, other information flows (business, drug, patent and statutory) are still emerging in China.

Table 9.2 Major Differences in Pharm. Infor. Information Flow in China and UK

	Britain	China
1	A mixture flow of S&T inf. business inf. drug inf. patent inf. & statutory inf.	S&T information in dominance with smaller patent inf. flow and business inf. flow
2	British scientists	Chinese scientists
(1)	English (native language) is predominant language in work	English (foreign language) is predominant language in work
(2)	UK leading position in drug R&D in the world	smaller impact on drug R&D in the world
(3)	general satisfaction with information access/document supply	general unsatisfactory with information access/document supply
(4)	frequent informal communication	less use informal communication
(5)	enhanced searching ability by online	very limited access to online services
(6)	higher publishing capacity	lower publishing capacity
(7)	disseminating R&D results at world level	disseminating R&D results at national level (only 4% papers published in world journal, 10% papers covered by world secondary publication)
(8)	Eminent one publishes 3 paper each year in life time (eminence: 0.4% of total S&T workers in UK)	Eminent one publishes 3 papers each year in world journal (eminence: 0.0005% of total S&T workers in China)
(9)	cite more papers (18.2 in average) and 90% citation in Eng.	cite less papers (8.6 in average) and 50% citation in Eng.
(10)	focused Infor. use over subject width	diffuse Infor. use over subject width
(11)	use wider time span of literature, cite more, "age" literature faster- focused and effective use of information	use shorter time span of literature, cite less, "age" literature slowly- diffuse and less effective use of information
3	S&T literature publishing industry	S&T literature publishing industry
	bigger capacity in disseminating S&T information (4000 S&T journals against 220,000 S&T workers)	smaller capacity in disseminating S&T information (3000 S&T journals against 7.8 million S&T workers)
4	Abstracting and indexing services	Abstracting and indexing services
	430 services, 3 million bibliographic record p.a. 93 online databases	229 services, 1.5 million bibliographic record p.a.

continued

5	S&T library system	S&T library system
(1)	comprehensive collection in BLDSC (55,000 world journals p.a.)	no comprehensive collection at national centres (NL, ISTIC etc.- 3-7,000 world journals at each centre)
(2)	a central document supply system for the whole country	no national or regional document supply scheme
(3)	better situation in S&T libraries especially in Pharm. company S&T libraries	generally limited resources in S&T libraries especially in Pharm. factory S&T libraries
(4)	235.6% inflation rate in academic journal price (1980-1988)	329% inflation rate in foreign academic journal price (1985-1989)
(5)		dual price system for domestic and foreign S&T information (annual price ¥15 for Chinese journal and ¥1500 for foreign journal in 1989)
6	UK business information revenue up to one billion US dollars in 1989	China S&T information (including small part of business inf.) revenue ¥50 million (or $10 million) in 1989
7	A national drug information network exists in NHS	no formal drug information system
	Most UK pharmaceutical companies provide formal drug information to health professional	Most Chinese pharmaceutical factories do not provide formal drug information
8	A patent system protects pharmaceuticals	A patent system do not protect pharmaceuticals
	National patent information network including SIRS, 7 local libraries and 12 inf. centres- good situation in resource sharing	National patent information network including CPO, 62 local inf. centres- not very good in resource sharing
9	A sophisticated drug regulatory system	A basic drug regulatory system
	higher standard in information requirement for new drug application	lower standard in information requirement for new drug application
10	Pharm. Infor. as a profession in the practical and academic terms	General S&T Infor. profession only

Although S&T information flow has been developed for 40 years, there are still serious problems in scientific communication in China.

1. Great dependence on foreign S&T information.
There are about seven countries in the leading position of pharmaceutical R&D in the world. About 70% of the world S&T literature are in English. Two problems resulting from this are language barriers and financial constraints in importing of S&T information.

2. Language barriers.
To solve the language problems in information searching, China has put great effort on compiling secondary publications for foreign literature and on foreign information analysis and research services. The cost effectiveness of these services need to be evaluated.

Language barriers have obstructed the worldwide dissemination of Chinese S&T information. Although CA gives Chinese literature 3.5% coverage each year, 98% of these papers are in Chinese. Even so, these CA indexed papers are estimated to represent only 15% of total Chinese papers in the corresponding fields. Also it is estimated only 4% of Chinese literature are published in international journals.

3. Little impact on the world and poor communication for Chinese scientists.

Chinese scientists (even those eminent ones) have very little impact on the world scientific community. Major reasons are the backwardness in R&D, lack of means for dissemination (journal, patent, secondary publication), and language barriers etc.. The results of little impact are that Chinese scientists are excluded from worldwide informal communication (invisible college etc.) and could not get information through informal channels. Little impact also reduce the opportunities for foreign investment to develop potential Chinese products.

4. Two scientific communication circuits and distinction between eminent and ordinary scientists in China.

There are two scientific communication circuits/pathways- one at the international level and one at the national level. The distinction between eminent and ordinary Chinese scientists are that the former communicate at the international level whereas the latter can only communicate at the national level.

An eminent Chinese scientist publishes 3-4 papers in world journals per year whereas ordinary scientists publish one paper in Chinese journals per year on the average. About 0.1% of 400,000 Chinese scientific authors are up to this eminent standard. Most of eminent Chinese scientists have some work experience abroad. They could access foreign S&T information more widely than ordinary scientists through informal channels. Literature aging analysis suggests that eminent Chinese scientists use and absorb foreign information more effectively than ordinary scientists.

5. Compared with British scientists, Chinese scientists have lower information accessing and searching ability, mainly because of lack of interlending and online services.

6. Compared with British scientists, Chinese scientists have lower information disseminating ability, mainly because of lack of journals, secondary publications in China and low Chinese coverage by world primary and secondary publications.

7. Chinese scientists cite less papers, user shorter time span of literature, "age" literature more slowly than British scientists. They also show diffuse information use over subject width. In a sense, these may reflect the difficulty for them to get hold of foreign S&T information.

Above are some problems identified in this study. By no means comprehensive, the above problems show that there is a great necessity for improvement or reform on the current S&T information flow in China.

9.9.2 Prospects for A Future System

This project try to approach the comparison of information flow in the two countries in a systematic way, that is to compare pharmaceutical information flow in a country under its wider system *"national pharmaceutical industry"*, its special environment *"national pharmaceutical activity"*, as well as its general information environment. Such a comparison shows that differences in national pharmaceutical industry and national pharmaceutical activity determine the different status and function of pharmaceutical information flow between the two countries.

In the UK pharmaceutical information flow system, the industry information work plays a central role which embraces all major information flows including scientific information, business information, drug information, statutory information and patent information. The pharmaceutical information flow is the "nerve system" of the national pharmaceutical industry. S&T information, business information, patent information are directly related to the industry while statutory information and drug information are indirectly linked with the industry. In that sense, the pharmaceutical information flow may be called as industry led information flow and represents the **big information** in advanced industrial countries.

By comparison, the pharmaceutical information flow is not being separated from general S&T information flow in China. The less sophisticated national pharmaceutical industry has a premature "nerve system" in which excepting scientific information, other information flows are still in the infancy. The backwardness in other information flows will slow the modernization of Chinese pharmaceutical industry and prevent pharmaceutical R&D from fast growing. This will in turn prohibit the improvement of scientific information flow. The very limited industry involvement in R&D activities and therefore in information work seems makes the fundamental difference in the pharmaceutical information flow between the two countries. Without the industry demand, commitment and participation, the isolated scientific information flow represents a **little information** in the less industrialized countries.

Such a comparison sheds a light on the reform of current S&T information system in China. The reform and modernization of current S&T information system must parallel with the reform and modernization of national industry and national science & technology.

The current development of the Chinese S&T and pharmaceutical industry has provided a favourable environment for a future pharmaceutical information flow system in China. As described early in Chapter 1, the current S&T reform (1985-) is aiming at speeding up the industrial development and market realization of S&T activities by linking government research closely with industry. The economic reform (1979-) has greatly accelerated the shaking up of the Chinese research based pharmaceutical industry and the internationalization of the Chinese industry and healthcare market. During the second half of 1980s, the number of Chinese-foreign joint venture has grown from none to nearly one hundred. In 1985, China introduced the Medicine Act. In 1992, China will introduce pharmaceutical patent protection.

In the near future in China, there will be a healthcare market opening to both Chinese and foreign drug companies. The market competition will mainly be in ethical or patent drugs. Facing these changes, SPAC is working on a plan for the future Chinese R&D pharmaceutical industry (Industry Trade News, 1 Jan. 1992).

In China, since 1949 there has been an improved and more widely available health care system which encouraged an increase in the drug market. The Chinese pharmaceutical industry has increased its output at a rate of 10% p.a. for the past decade. Many issues that used to exist only in the developed countries are emerging in China, such as drug information provision, ADR monitoring, legislation, and mass media coverage etc..

Above all, a favourable environment has been created for a future Chinese pharmaceutical information flow system.

9.9.3 Consideration and Recommendation for the Future System

[A] About system missions

Mission 1. to support R&D in the Chinese pharmaceutical industry and ensure that R&D workers are able to derive benefit from all the information in the public domain. This means that the current S&T information work should be extended from government research institutes to industry laboratories, from journal source to patent source and from traditional library work to specialist information services.

Mission 2. to support commercial activities of the Chinese pharmaceutical industry. Because of the "open door" economic policy and the introduction of Chinese pharmaceutical patent protection, the Chinese pharmaceutical industry will compete with foreign companies on a domestic market which used to be monopolized by itself. Furthermore, the Chinese pharmaceutical industry is expending its export capacity from bulk pharmaceuticals and TCM raw materials to ethical drugs. The future competition will be mainly in ethical drug market (nationwide and worldwide) among the Chinese industry and foreign companies. Therefore, the R&D of Chinese medicines will be targeted not only in a scientific sense, but also commercially. It is predicted that the Chinese business information concerning regional disease profiles, healthcare systems, market sizes, regulatory constraints, competitors, sales statistics and so on will be in great demand by both the Chinese and foreign companies.

Mission 3. to provide drug information to the healthcare professional and the public for rational use of drugs. Along with the improvement of healthcare services and the increase of drug consumption in China, more and more Chinese people could access to new drugs and sophisticated drugs than ever before. The transition of the Chinese pharmaceutical industry into a R&D based industry and the internationalization of domestic market will result in a gradual development from essential and generic drug consumption to ethical drug consumption in China. Therefore, it is predicted that there will be an increase in the importance of drug information provision for safe and rational use of drugs. Both the MPH hospitals and the Chinese and foreign companies have the responsibility for the drug information provision.

Mission 4. to build up a statutory information system in the MPH legislation department to control the whole process from drug research, through development, clinical trials, market launch to ADR monitoring and postmarket surveillance; to encourage and organize mass media in monitoring drug use; to enhance the communication among the industry, the authorities and the public.

[B] About the system decision taking process

Because of the central control political situation, there is a possibility to create a Central Pharmaceutical Information Committee in managing the future pharmaceutical information flow system in China. The Committee will appoint directors for R&D information section, business information section, drug information section, statutory information section, and the patent information section. The members of the Committee will include the chief information officers of SPAC, SATCM, MPH and Academia Sinica, so that in the future there will be information resource sharing among these major ministries. To integrate scientific, business, drug, statutory and patent information management under the central control could help the transition from information for invention to information for innovation.

[C] About the resources at and beyond the disposal of the central Committee

There are 57 research institutes in SPAC, 60 in SATCM, 411 in MPH plus 50 pharmaceutical colleges/university departments. In addition, there are about several dozen pharmaceutical related research institutes in Academia Sinica. Every institute has a S&T library and/or information unit.

Furthermore, within SPAC, SATCM, MPH and Academia Sinica there are S&T information services under the ministerial control. Beijing Library of Academia

Sinica, S&T Information Institute of Chinese Academy of Medical Sciences, Shanghai Library of Academia Sinica and Shanghai S&T Information Institute of Pharmaceutical Industry are the largest information centres each with several hundred to several thousand foreign journals.

The central Committee will coordinate in acquisition, bibliographical control (i.e. union catalogue etc.) among these large information centres. There is a further need to create an interlending network among these large information centres and the hundreds of R&D institutes/laboratories in the Chinese pharmaceutical industry.

Beyond the control of the central Committee, there are several national S&T information services that could back up the future Chinese pharmaceutical information system. They are the National Library, Shanghai Library, Shanghai Institute of S&T Information and ISTIC each with annual intake of several thousand foreign journals. The Chinese Patent Office (CPO) has an annual intake of one million world patents. The problem in the current S&T information flow in China is that more than 50% of imported foreign S&T documents are concentrated in Beijing and much of these foreign information are concentrated in the above several national information centres (see §8.1.2). The central Committee needs to consider the possibility in building up a special information service to collect documents from the above national centres and distribute them to R&D workers in the Chinese pharmaceutical industry.

Apart from the traditional S&T libraries and information centres, the following resources need to be explored:

(1) About 2-300 large Chinese pharmaceutical manufacturers with R&D units and S&T information units.

(2) About 100 Chinese-foreign joint ventures with access to the world information sources through their parent companies abroad.

(3) Several business information services in SPAC and some SPAC industrial corporations having control of some kind of national business information.

(4) MPH hospitals as potential drug information suppliers.

(5) The legislation department in MPH as a potential statutory information system.

(6) The medical representatives of pharmaceutical companies as potential industry customer information providers.

(7) About five hundred national medical and pharmaceutical journals are not enough for Chinese scientists to publish. There are very few Chinese journals published in English. To increase the the journal publishing capacity would increase the impact of Chinese scientists nationwide and worldwide and improve the scientific communication in China.

(8) SPAC publishes China Pharmaceutical Abstracts bimonthly with annual volume of 9000 records. There is a need to speed up the publication and increase the coverage of Chinese literature. Finally it is expected to provide online service.

(9) About 20% of S&T information staff have first degrees in foreign language study and work in the field "foreign information analysis and research". This is one kind of very important resources. The central Committee needs to evaluate this kind of information work against the users needs in order to improve this kind of services.

[D] About measuring the performance

The following indicators are recommended for measuring the system performance but need specific standards:

(1) Scientific journal publishing capacity

Are there enough S&T journals for disseminating Chinese S&T information nationwide and worldwide?

(2) Secondary services

The coverage of Chinese S&T literature, the publishing speed needs to be increased. It is needed to review the investment in compiling foreign secondary publications vs compiling domestic secondary publications. It needs to assess the progress in computerization of secondary services.

(3) Scientists' information accessing ability

Can scientists get essential document supply locally? Can they get most of documents needed through local sources and national interlending network?

(4) Scientists' information searching ability

Can scientists get effective information services such as SDI, inhouse bulletin, offline and online searching, CD-ROM, translation etc..

(5) Chinese scientists/journals impacts on the world

This is an indirect measurement. It is likely that as the Chinese impacts increase in the world, Chinese scientists could get more information through informal communication channels.

(6) Scientists' citing pattern

This is an indirect measurement. It is likely that as the information service and supply as well as informal communication are improved, Chinese scientists may cite more papers, use wider time span of literature, "age" literature fast, than they used to.

(7) Effective patent information service

The current national patent information network with CPO as the central collection and 62 regional searching units will be fully used by the future Chinese pharmaceutical information system. The high cost of pharmaceutical R&D means that every R&D companies or institutes will compete in early patent application and many marketers will compete in good licensing opportunity. In the future Chinese pharmaceutical information system, the patent information section will include a central patent supply service which works closely with CPO and several hundred patent units in pharmaceutical companies and in research institutes. The measurement of patent information section should be fast and comprehensive patent supply and effective patent searching and disseminating.

(8) A profitable business information section

The future Chinese pharmaceutical information system will provide the Chinese and foreign pharmaceutical industry with cost effective services of market information, product information, company information, etc.. The first step is to focus on domestic information sources. The next will expend the coverage to world information. One measurement is the annual turnover. This is the only section in the future Chinese pharmaceutical information system which generates significant revenues. The profit of business information services could be invested in R&D information and drug information section.

(9) Information for rational use of drugs

As the Chinese consumption of ethical drugs increases, to ensure safe and rational use of drugs is the aim of both the healthcare professional and the pharmaceutical industry. The future information system will include a MPH hospital drug information network and consumer information services provided by pharmaceutical companies.

To measure the performance of drug information section both user survey and inquiry statistics could be applied.

(10) A statutory information system up to international standards

The MPH legislation authority and statutory information system will raise standards for drug research , development, registration, production, marketing, and post market surveillance. So that these standards will be up to the international standards to protect Chinese customers' right. This will also help the Chinese pharmaceutical industry to become more competitive in the world market.

Finally, in order to build up an advanced pharmaceutical information flow system in China, a detailed financial condition assessment must be carried out. The current government information funding as part of R&D funds in SPAC, SATCM, MPH and Academia Sinica are not expected to grow significantly under the S&T reform. Therefore other alternative incomes must be identified and sought. For example, as the Chinese pharmaceutical industry increases its R&D investment, certain fraction of the money should be used for information services. The future Chinese pharmaceutical information flow system will charge for business information and perhaps patent information services. The central Committee should find some ways (tax etc.) to reallocate this income to other non profit services such as S&T interlending network, S&T publishing, abstracting & indexing services, and hospital drug information services, and so on.

Appendices

2.1 Administrative Divisions and Population Distribution

Source: State Statistical Bureau figures as reported in Beijing Review, 3 January 1983

units at provincial level	area (000s sq. km.)	population (000,000s)	units at pre-fectural level	cities	units at county level
total 30	9,600	1,031	208	230	2136
Beijing	16.8	9.2			10
Tianjin	11.3	7.7			13
Hebei	180	53.0	10	10	39
Shanxi	156	25.2	7	7	101
Inner Mongolian	1200	19.2	9	10	79
Liaoning	140	35.7	2	13	45
Jilin	180	22.5	4	9	37
Heilong-jiang	460	32.6	7	12	66
Shanghai	6.2	11.8			10
Jiansu	100	60.5	7	11	64
Zhejiang	100	38.8	7	9	62
Anhui	130	49.6	8	12	70
Fujia	120	25.9	7	7	61
Jiangxi	160	33.1	6	10	81
Shandong	150	74.4	9	9	106
Henan	167	74.4	10	17	111
Hubei	180	47.8	8	11	73
Hunan	210	54.0	11	14	89
Guangdong	210	59.2	9	14	96

Guangxi	230	36.4	8	7	80
Sichuan	560	99.7	14	13	182
Guizhou	170	28.5	7	5	79
Yunnan	390	32.5	15	6	123
Xizang	1200	1.8	5	1	71
Shanxi	200	28.9	7	6	91
Gansu	450	19.5	10	5	73
Qinghai	720	3.8	7	2	37
Ningxia	60	3.8	2	2	16
Xinjiang	1600	13.0	12	8	80
Taiwan	36	18.2			

2.2 Inflation Rate in UK & China (1981-1988)

Source from:

1. European Marketing Data & Statistics 1991, 26th ed. Euromonitor Publication Ltd, London 1991

2. Hartland-Thunberg, 1990

Year	1981	1982	1983	1984	1985	1986	1987	1988
China %	2.5	2	2	2.7	11.9	7	8.8	27
UK %	11.9	8.6	4.6	5.0	6.1	3.4	4.2	4.9

2.3 Foreign Exchange Rate in UK and China (1983-1989)

Source from International Financial Statistics Yearbook 1990

Year	1983	1984	1985	1986	1987	1988	1989
$ per ¥	1.9809	2.7957	3.2015	3.7221	3.7221	3.7221	4.7221
£ per $	1.4506	1.1565	1.4445	1.4745	1.8715	1.8095	1.6055
£ per ¥*	2.87	3.23	4.63	5.49	6.97	6.74	7.58

* the exchange rate between £ and ¥ is from the calculation of the first two lines

5.1 Drug Information Services in Hospital -Questionnaire to Hospital Pharmacists (1989)

1. Are you responsible for drug inquiry?

2. Please point out the category of questions occurring to you:

   (1) administration/dosage

   (2) availability/supply

   (3) adverse reactions/side effects:

   (4) identifications

   (5) identifications/contraindications/clinical use

   (6) interactions

   (7) poisoning/toxicity

   (8) pharmaceutical information

   (9) pharmacology

   (10) others

3. Status of inquirers:

   (1) doctors and nurses in the hospital

   (2) doctors and nurses from other hospital

   (3) patients and others

4. How many inquiries do you answer per day?

5. Information sources for drug information:

5.1 using reference collection in the hospital - (%)
using external information sources - (%)

5.2 consulting pharmacists in other hospitals - (%)
consulting pharmaceutical manufacturers - (%)
depending on own knowledge - (%)

6. Please name heavily used reference books:
(3 Chinese books and 3 foreign books)

7. Source for new drug information:

(1) pharmacists in other hospitals

(2) posted advertisements

(3) promotional literature in journals

(4) industrial representatives

(5) market and fair for medicines

(6) others

8. ADR monitoring:

(1) report to the manufacturers

(2) report to the government authority (MPH)

(3) inform doctors in the hospital

(4) report in professional journals

(5) others

9. Name the mostly used journals for drug information
(2 Chinese journals and 2 foreign journals)

5.2 Drug Information Needs and Sources
- Questionnaire to Doctors

1. Sources for new drug information:

(1) hospital pharmacists

(2) promotional literature in journals

(3) posted advertisement

(4) industrial representatives

(5) market and fair for medicines

(6) others

2. Sources for the following questions:

Information sources:	pharmacists	pharma. factories	information services	own knowledge
Questions: administration/dosage				
availability/supply				
ADR/side effects				
identification				
identification/contraindication/clinical use				
interactions				
poisoning/toxicity				
pharmaceutical information				
pharmacology				
others				

3. ADR monitoring:

(1) report to pharmaceutical manufacturers

(2) report to the government authority (MPH)

(3) report to pharmacists

(4) report in professional journals

(5) others

4. Do you often use library and information centre?

5. How often do you use internal and external information services?

- using internal information service account for (%)
- using external information service account for (%)

6. How do you use Chinese and foreign journals for drug information?

- using Chinese journals account for (%)
  using foreign journals account for (%)

7. Please name the mostly used reference books for drug information:

(2 Chinese books and 2 foreign books).

5.3 Scientific Information Needs
- Questionnaire to Pharmaceutical Scientists

1. Please describe your work:

   (1) basic research

   (2) R&D

   (3) the industry related R&D

2. Please name the major foreign languages you use in research work.

3. Please name current information sources ( ) and retrospective searching sources( ):

   (1) Scanning journals

   (2) Reviews

   (3) Following up references

   (4) Inhouse information bulletins

   (5) Abstracting and indexing journals

   (6) Computer information retrieval

   (7) Current Contents

   (8) Personal contacts

   (9) Conference communication

4. Please name the heavily used information materials:

(1) books

(2) journals

(3) patents

(4) standards

(5) reports

(6) grey literature

5. Have you ever use the following information services?

(1) ISTIC

(2) NL

(3) Chinese Patent Office

(4) Ministerial Information Services

(5) Provincial information services

6. How much can the information service in your research organization satisfy your information needs?

(1) less than 50%

(2) more than 50%

(3) more than 80%

7. Have you ever done international online searching?
Do you satisfy with the retrieval results?

8. Have you ever missed any important information? What are the causes?

(1) failing to trace literature

(2) failing to gain documents

(3) cannot read foreign language literature

9. Which of the following information services need to be strengthen?

(1) building up databases

(2) foreign information analysis and research

(3) Inhouse information bulletins

(4) searching for users

(5) documents supply

(6) translating

(7) SDI

5.4 Information for Pharmaceutical Factories
- Questionnaire to Factories

1. Is there a business information division in the factory?

If not, is there any other divisions responsible for business or market information in the factory?

2. Major sources for business information:

(1) market or fair for medicines

(2) the government departments

(3) information services

(4) others

3. Please name the major information sources:
(3 government departments, 3 information services)

4. How do you promote your pharmaceutical products?

(1) promotional literature in journals

(2) posted advertisements

(3) representatives

(4) market / fair / conference

(5) others

5. Have your factory ever used any online business databases?

(1) name 2 Chinese databases

(2) name 2 foreign databases

5.5 Scientific Information Services
- Questionnaire to S&T Information Organizations

1. Title of the information organization, telephone No., Telex No.

2. Address and post code:

3. Staff number and the director:

4. the divisions or units in the organization

	unit title	group leader	staff number	major work
unit1				
unit2				
unit3				
...				

5. information publication or inhouse bulletins:

6. information technology facility:

7. information resource

Chinese information   foreign information   video tape   and others

8. the number of foreign information analysis and research for the last two years:

9. the income of information services for the last two years:

10. annual fund and expenditure:

11. other information about the organization:

6.4.1 Bradford Distribution of Chinese citations in -Pharmaceutical Analysis (1984-1987) (China)

No. of journals	No. of citations	Total citations	Rank (n)	Cumulative No. of citations
1	180	180	1	180
1	111	111	2	291
1	78	78	3	369
1	48	48	4	417
2	28	56	6	473
1	22	22	7	495
1	18	18	8	513
1	17	17	9	530
2	16	32	11	562
1	15	15	12	577
1	10	10	13	587
1	9	9	14	596
1	8	8	15	604
	7-1		125	813

6.4.2 Bradford Distribution of English citations in -Pharmaceutical Analysis (1984-1987) (China)

No. of journals	No. of citations	Total citations	Rank (n)	Cumulative No. of citations
1	86	86	1	86
1	82	82	2	168
1	63	63	3	231
1	41	41	4	272
1	26	26	5	298
2	24	48	7	346
1	21	21	8	367
2	12	24	10	391
2	11	22	12	413
1	10	10	13	423
1	9	9	14	432
	8-1		215	822

6.4.3 Bradford Distribution of citations in -Pharmaceutical Analysis (1984-1987) (China)

No. of journals	No. of citations	Total citations	Rank (n)	Cumulative No. of citations
1	180	180	1	180
1	111	111	2	291
1	86	86	3	377
1	82	82	4	459
1	78	78	5	537
1	63	63	6	600
1	48	48	7	648
1	41	41	8	689
2	28	56	10	745
1	26	26	11	771
2	24	48	13	819
1	22	22	14	841
1	21	21	15	862
1	18	18	16	880
1	17	17	17	897
2	16	32	19	929
1	15	15	20	944
2	12	24	22	968
2	11	22	24	990
2	10	20	26	1010
2	9	18	28	1028
1	8	8	29	1036
311	7-1	599	340	1635

6.4.4 Bradford Distribution of Chinese citations in CJCP (1985-1987) (China)

No. of journals	No. of citations	Total citations	Rank (n)	Cumulative No. of citations
1	18	18	1	18
1	16	16	2	34
1	14	14	3	48
1	13	13	4	61
1	12	12	5	73
1	11	11	6	84
1	8	8	7	92
3	7	21	10	113
1	6	6	11	119
4	5	20	15	139
3	4	12	18	151
11	3	33	29	184
10	2	20	39	204
37	1	37	76	241

6.4.5 Bradford Distribution of English citations in CJCP (1985-1987) (China)

No. of journals	No. of citations	Total citations	Rank (n)	Cumulative No. of citations
1	51	51	1	51
1	44	44	2	95
1	33	33	3	128
1	27	27	4	155
1	25	25	5	180
1	21	21	6	201
2	20	40	8	241
1	17	17	9	258
1	16	16	10	274
2	15	30	12	304
3	14	42	15	346
2	13	26	17	372
3	12	36	20	408
3	10	30	23	438
1	9	9	24	447
2	8	16	26	463
1	7	7	27	470
4	6	24	31	494
6	5	30	37	524
12	4	48	49	572
19	3	57	68	629
44	2	88	112	717
112	1	112	224	829

6.4.6 Bradford Distribution of citations in CJCP (1985-1987) (China)

No. of journals	No. of citations	Total citations	Rank (n)	Cumulative No. of citations
1	51	51	1	51
1	44	44	2	95
1	33	33	3	128
1	27	27	4	155
1	25	25	5	180
1	21	21	6	201
2	20	40	8	241
1	18	18	9	259
1	17	17	10	276
2	16	32	12	308
2	15	30	14	338
4	14	56	18	394
3	13	39	21	433
4	12	48	25	481
1	11	11	26	492
3	10	30	29	522
1	9	9	30	531
3	8	24	33	555
4	7	28	37	583
5	6	30	42	613
10	5	50	52	663
15	4	60	67	723
30	3	90	97	813
54	2	108	151	921
149	1	149	300	1070

6.4.7 Bradford Distribution of citations in BJCP (Jan. - June, 1984) (UK)

No. of journals	No. of citations	Total citations	Rank (n)	Cumulative No. of citations
1	260	260	1	260
1	160	160	2	420
1	66	66	3	486
1	65	65	4	551
1	64	64	5	615
1	61	61	6	676
1	45	45	7	721
1	36	36	8	757
1	33	33	9	790
1	30	30	10	820
1	28	28	11	848
1	24	24	12	872
2	22	44	14	916
1	21	21	15	937
1	20	20	16	957
2	19	38	18	995
2	18	36	20	1031
1	17	17	21	1048
2	16	32	23	1080
2	15	30	25	1110
2	13	26	27	1136
2	12	24	29	1160
4	11	44	33	1204
8	10	80	41	1284
5	9	45	46	1329
8	8	64	54	1393
9	7	63	63	1456
6	6	36	69	1492
7	5	35	76	1527
28	4	112	104	1639
20	3	60	124	1699
49	2	98	173	1797
133	1	133	306	1930

6.4.8 Bradford Distribution of citations in Annual Reviews of Pharmacology (1968-1970) (USA)

No. of journals	No. of citations	Total citations	Rank (n)	Cumulative No. of citations
1	555	555	1	555
1	409	409	2	964
1	276	276	3	1240
1	264	264	4	1504
1	245	245	5	1749
1	226	226	6	1975
1	219	219	7	2194
1	217	217	8	2411
1	212	212	9	2623
1	168	168	10	2791
1	150	150	11	2941
2	135	270	13	3211
2	127	254	15	3465
1	125	125	16	3590
1	121	121	17	3711
1	120	120	18	3831
1	116	116	19	3947
1	108	108	20	4055
1	107	107	21	4162
1	105	105	22	4267
1	94	94	23	4361
1	89	89	24	4450
1	86	86	25	4536
2	83	166	27	4702
1	82	82	28	4784
1	78	78	29	4862
2	76	152	31	5014
1	74	74	32	5088
1	71	71	33	5159

1	70	70	34	5229
1	68	68	35	5297
1	67	67	36	5364
1	64	64	37	5428
2	58	116	39	5544
1	53	53	40	5597
1	51	51	41	5648
2	50	100	43	5748
1	49	49	44	5797
1	44	44	45	5841
2	43	86	47	5927
1	42	42	48	5969
1	41	41	49	6010
2	40	80	51	6090
1	38	38	52	6128
1	37	37	53	6165
2	36	72	55	6237
1	35	35	56	6272
1	34	34	57	6306
1	33	33	58	6339
1	32	32	59	6371
5	31	155	64	6526
2	30	60	66	6586
1	28	28	67	6614
2	27	54	69	6668
1	26	26	70	6694
3	25	75	73	6769
1	24	24	74	6793
4	23	92	78	6885
5	22	110	83	6995
2	21	42	85	7037
4	19	76	89	7113
7	18	126	96	7239

7	17	119	103	7358
5	16	80	108	7438
5	15	75	113	7513
5	14	70	118	7583
6	13	78	124	7661
7	12	84	131	7745
12	11	132	143	7877
7	10	70	150	7947
8	9	72	158	8019
8	8	64	166	8083
27	7	189	193	8272
34	6	204	227	8476
552	1-5	1025	779	9501

6.4.9 Bradford distribution of articles among journals - case of CJCP(1985-1987)

Rank(n)	No of journals	No. of Eng.Jr.	No. of Ch. Jr.	No. of papers
1	1	1	0	51
2	1	1	0	44
3	1	1	0	33
4	1	1	0	27
5	1	1	0	25
6	1	1	0	21
8	2	2	0	20
9	1	0	1	18
10	1	1	0	17
12	2	1	1	16
14	2	2	0	15
18	4	3	1	14
21	3	2	1	13
25	4	3	1	12
26	1	0	1	11
29	3	3	0	10
30	1	1	0	9
33	3	2	1	8
37	4	1	3	7
42	5	4	1	6
52	10	6	4	5
67	15	12	3	4
97	30	19	11	3
151	54	44	10	2
300	149	112	37	1

References

ABPI (1985)
The Pharmaceutical Industry and the Nation's Health, London.

ABPI (1987)
ABPI. Pharm Facts' 1986, London.

ABPI (1988a)
Annul Report (1987-88), London.

ABPI (1988b)
British Medicines Research, London.

ABPI (1991)
ABPI Pharm Figures and Facts' 1990, London.

Academia Sinica (1987)
My S&T Career in China, Economy Press, Beijing.

Academia Sinica (1991)
Information Development Policy, Internal Report, Beijing.

Allen, G. F. ed. (1989)
Jane's World Railways 1989-1990, Jane's Information Group Ltd., London.

Andrews, T. (1986)
Guide to the Literature of Pharmacy & Pharmaceutical Sciences, Libraries Unlimited Inc., New York.

Annual Review of Government Founded R&D 1990, HMSO, London, 1990.

Archer, M. (1990)
Technical Development and Production Information, in W. R. Pickering ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

Augustus, E. R. (1981)
A Survey of the Tasks Performed and Training Received by Information Scientists Working in Pharmaceutical, Biomedical and Nonbiomedical Information Processing, MSc. Thesis, TCU, London.

The British Library Annual Report 1987-1988, London, 1988.

BLDSC Information Package 1990, Boston Spa, 1990.

Baglow, G. and Bottle, R. T. (1979)
Rate of Publication of British Chemists, Chemistry in Britain, 5(3):138-141.

Baker, R. H. K. (1989)
Science Policy: The Way Ahead, HMSO, London.

Bawden, D. (1989)
Ten Years of Online Information for Pharmaceutical Research, the 13th International Online Information Meeting, London.

Bawden, D. Lecturer at Dept. of Information Science, TCU London, personal communication, 1991.

Bottle, R. T. (1979)
Use of Chemical Literature 3rd ed., Butterworth, London, 1979 and 4th ed. in print, 1991.

Boxenbaum, H. (1982)
Literature Growth in Pharmacokinetics, Journal of Pharmacokinetics and Biopharmaceutics, 10(3): 335-348.

Breckon, W. (1972)
The Drug Makers, Eyre Metuen Ltd., London.

Britain 1990: An Official Handbook, HMSO, London, 1990.

Britain 1991: An Official Handbook, HMSO, London, 1991.

Brookes, B. C. (1969)
The Complete Bradford-Zipf Bibliograph, Journal of Documentation, 25(1): 58-60.

Brookes, B. C. (1973)
Numerical Methods of Analysis, Library Trends, 18-43, July 1973.

Brown, H. D. (1985)
A Drug Is Born: Its Information Facts in Pharmaceutical Research and Development, J. Chem. Infor. Comput. Sci. 25(3): 218-223.

Bureau of International Cooperation in Academia Sinica, Internal Report, 1989.

Burrows, T. (1989)
British University Libraries, Haworth Press, New York.

Business Information Yearbook 1990/91, Headland Press, London, 1991.

Business Statistics Office (1989)
Business Monitoring, PQ4753, Quarter 1, 1989.

Byway, S. (1988)
End User Online Searching in the UK Chemical Industry, MSc. Thesis, TCU.

CD-ROM In Print 1988-89, Merckler, London, 1988.

CNPIEC (1988)
Directory of Foreign Newspapers and Periodicals: A CNPIEC Serials Bibliography, 7th ed. Beijing.

Calder G. et al. (1981)
Drug Information in the UK NHS, American Journal of Hospital Pharmacy, 38: 663-667, May 1981.

Checkland, P. (1981)
Systems Thinking Systems Practice, Willey, Chichester (UK).

Chen, M. (1989)
MPH Information Policy, Internal Report, Beijing.

China Pharmaceutical Yearbook 1987, People's Health Press, Beijing, 1988.

China Economic Statistics Yearbook 1988, China Economy Press, Beijing. 1988.

Clarck, J. L. (1985)
The Status of the Information in the Pharmaceutical Industry, MSc Thesis, TCU.

Coile, R. G. (1977)
Lotka's Frequency Distribution of Scientific Productivity, Journal of the ASIS, 28:366-370, Nov. 1977.

Collett, D.M. and Aulton, M. E. ed. (1990)
Pharmaceutical Practice, Churchhill Livingstone, Edinburgh.

Crafts-Lighty, A. (1990)
Biologicals and Biotechnology Information in W. R. Pickering ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

Crawford, M. J. (1988)
Information Broking: A New Career in Information Work, LA Publishing Ltd., London.

Cuadra's Directory of Online Databases 1991, Cuadra/Elsevier. New York. 1991.

Cuddihy, R.V. (1975)
Scientific Information: Philosophy and Policies Within the Pharmaceutical Industry, in S. B. Day ed. Communication of Scientific Information, S. Karger AG., Basel (Switzerland).

Dale, J. R. (1985)
Pharmacy Law and Ethics, The Pharmaceutical Press, London.

Davies, B. (1982)
The National Drug Information Network, MIMS Magazine, p9-13, Aug. 1982.

Dennis, W. (1954)
Bibliographies of Eminent Scientists, Science Monthly 79:180-183, Sep. 1954.

Dingwall, D. W. (1977)
The GP's Information Requirements in Prescribing, Postgraduate Medical Journal, 53: 545-547, Sep. 1977.

Duckitt, P. (1990)
Biological and Biomedical Information in W. R. Pickering ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

Dukes, G. (1985)
The Effects of Drug Regulation, WHO report, MTP Press Ltd. UK.

East, H. & Forrest, V. (1990)
Institutional Markets for Online Services, Online Review, 14(4):238-250.

Economist Newspaper Ltd. ed. (1987)
The World in Figures, Macmillan Press Ltd. 3rd ed. London.

Eisenschtz, T (1990)
Intellectual Property in W. R. Pickering ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

Enright, B. J. (1990)
Concepts of Stock: Comprehensive vs. Selective in M. B. Line ed. Academic Library Management, LA, London.

Europa World Yearbook 1989, Eueopa Publication Ltd., London, 1989.

Fang, X. et al. (1986)
Chinese Academy of Science: An Introduction, Bulletin of Chinese Academy of Science, 1(1):29-35.

Far East and Australasia 1990, Europan Publish Ltd. 21St. ed. London, 1989.

Fischer, M. et al. (1990)
The Electronic Information Industry and Forecast, 14th International Online Information Meeting, London.

Fletcher, J. (1987)
Inflation Indexes for Academic Library Purchases, Library Association Record, 89(8):400-403, Aug. 1987.

Foskett, D. J. (1989)
National Surveys of Library and Information Services I: China, BLRDD, London.

Frame, J. D. & Narin, F. (1987)
The Growth of Chinese Scientific Research 1973-1984, Scientometrics, 12:135-144.

Garfield, E. (1972)
Citation Analysis as a Tool in Journal Evaluation, Science, 178:471-478, Nov. 1972.

Garfield, E. (1983)
Mapping Science in the Third World, Science and Public Policy, 112-127, June 1983.

Garvey, W. D. et. al. (1972)
Research in Patterns of Scientific Communication I-IV, Inform. Stor. Retr. 8:111-122, 159-169, 207-221, 265-276, 1972.

Gong, Y. (1986)
Bibliometric Studies on Aging of the Biomedical Literature, MPhil, Thesis, TCU.

Gong, Y. (1990)
Information Needs and Availability in the P. R. China, in Pickering ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

Green Book: Modern Chinese Pharmaceutical Undertaking, China Social Science Press, Beijing, 1988.

Griffith B. C. et al. (1979)
The Aging of Scientific Literature, Journal of Documentation, 35(3): 179-196.

Gurnah, S. (1990)
Marketing and Business Information in Pickering ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

Han, B. (1988)
Drug Control in China, Chinese Pharmaceutical Affairs, 2(2):115-117.

Harrison, I. H. (1986)
The Law on Medicines, MTP Press Ltd. Lancaster, UK.

Harrison, J. (1990)
Legal and Regulatory Constraints upon Pharmaceutical Business, in Pickering, W. R. ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

Hartland-Thunberg, P. (1990)
China, HongKong, Taiwan and World Trading System, Macmillan Ltd. London.

Henderson, A. G. (1988)
The Growth of Science 1900-1988, MSc. Thesis, TCU.

Hibberd, P. L. (1980)
The British Drug Information Services, Aslib Proceeding, 32(10):408-415.

Hill, M. W. (1978)
Patent Documents: anticipated changes which will affect libraries, Journal of Librarianship, 10(2): 97-118.

Hill, M. W. (1982)
Information for Innovation: a view from the UK, Information and Innovation, ed. by B. T. Stern, North Holland Publishing Company, 115-148.

Hill, M. W. (1985)
Recent Development in Patent Documentation, International Forum on Information and Documentation, 10(2): 3-10.

Hill, M. W. (1987)
The Flow of Information, Paper delivered to the International Conference on Information and Knowledge, Yokohama, 11-13 November, 1987.

Howe, C. (1989)
Economy of The P. R. China, in the Far East and Australasia 1990, European Publish Ltd., London.

Howorth, G, B. (1988)
Access to Online Information Services in British University Libraries, MSc. Thesis, TCU.

Huang, M. (1986)
The Coverage of Chinese S&T Index in Medical Sciences, Medical Information Work Journal, (10):32-35.

Hubei Academy of Medical Sciences (1986)

Information User Study, Medical Information Work Journal, (4):11-15.

Hunter, K. R. (1977)
Information and Prescribing from Hospital Doctors' Viewpoint, Postgraduate Medical Journal, 53: 548-550, Sep. 1977.

Huntingford, A. L. et al. (1990)
A Survey of Industry Medical Information Departments' Activities, Pharmaceutical Journal, 238-239, Aug. 25, 1990.

Hyams, M. (1980)
Does Industry Make the Most of Information, Supplement to Inform, (32), 1980.

ISTIC (1982)
A Survey of Scientists Information Needs in China, Information Science Journal, 1(2):129-143.

ISTIC (1985)
National Survey on 3888 S&T Information Services, Beijing.

ISTIC (1986)
The Meeting of Experts on National S&T Information Policy in *China*, Beijing, 31 March-6 April, 1986.

Information China, Chinese Academy of Social Science and Pergamon Press, 1989.

International Monetary Found (1989)
International Financial Statistics 1989 Yearbook, Washington, D. C.

International Monetary Found (1990)
International Financial Statistics 1990 Yearbook, Washington, D.C.

Inventory of Abstracting and Indexing Services Produced in the UK, British Library, 1983.

Inventory of Abstracting and Indexing Services Produced in the UK, British Library, 1986.

Jackson, A. E. (1975)
Information Scientists in Pharmaceutical Industry, MSc. Thesis, TCU.

Jackson, A. R. H. (1987)
Journal Holding and Interlibrary Lending Policies in Pharmaceutical Industry, Inter-lending and Document Supply, 15(1):3-6.

Jackson, A. R. H. (1987)
Pharmaceuticals - An Information Based Industry, Aslib Proceedings, 39(3): 75-86.

Jepson, M. H. (1974)
Medicinal Product Registration in UK, MSc. Thesis, TCU.

Jhaveri, U. (1989)
Languages of Scientific Research, MSc Thesis, TCU.

Jin, G. J. (1986)
Medical Scientists Information Needs in Hubei Province, Medical Information Work Journal, (1):11-17.

Jin,G. (1988)
FSTDI and CSTDI, Medical Information Work Journal, (3):41-47.

Koenig, M. E. D. (1983)
A Bibliometric Analysis of Pharmaceutical Research, Research Policy, (12):15-36.

Lei, X. (1988)
Feasibility Study for a Current Research Information System in China, MPhil Thesis, TCU.

Li, A. (1988)
Bibliometrics Study on Chinese Journal of Pharmaceutical Science, Medical Information Work Journal, (6):45-49.

Library Year Book 1985-1987, James Clarke & Co. Ltd., Cambridge, 1989.

Line, M. B. (1970)
Half-life of Periodical Literature, Journal of Documentation, 26(1):45-54.

Line, M. B. & Sandison, A. (1974)
Obsolescence and Changes in the Use of Literature with Time, Journal of Documentation, 30(3):283-341.

Line, M. B. ed. (1990)
Academic Library Management, LA, London, 1990.

Liu, J. (1990)
Ph.D student at Department of Chemistry, TCU, Personal communication, 1990.

Lou, R. et al. (1989)
Chinese Medical University Library Union Catalogue of Foreign Journals, Medical Information Work Journal, (5):29-35.

Lu, X. (1990)
Doctor, Research Institute of Clinical Pharmacology, Beijing Medical University, personal communication, 1990.

Lumley, C. E. et al. (1989)
UK Pharmaceutical R&D Investment in 1980s, Pharmaceutical Journal, 243: 764-767.

Lyon, E. and Gilbert, S. (1988)
A Pilot Survey of User Satisfaction with Online Search Service in South West Thames Regional Libraries, Health Library Review, (5):49-60.

Ma, M. (1990)
Professor of Beijing Normal University, personal communication, 1990.

MRS Yearbook 1989, The Market Research Society, London, 1989.

Martyn, J. (1979)
Proliferation and Fragmentation of Journals in A. J. Meadows ed. Scientific Journal, Aslib Reader Series, Aslib, London.

Martyn, J. (1987)
Literature Searching Habits and Attitudes of Research Scientists, BLRDD paper No.14, London.

McNulty, H. (1984)
Investigation of Drug Information Requests in the South Western Region, Pharmaceutical Journal, 759-761, June 23 1984.

Meadows, A. J. (1974)
Communication in Science, Butterworths, London.

Meadows, A. J. ed. (1979)
Scientific Journal, Aslib, London.

The Medicine Act of China: 1985, MPH ed., People's Health Press, Beijing, 1987.

Meng, L. (1988)
Chinese Scientific Journals Statistcs, Academia Sinica Internal Report, 1988.

Morton L. T. & Godbolt, S. (1984)
Information Sources in Medical Sciences 3rd ed., Butterworths, London.

Mullen, A. (1990)
Chemical and Physicochemical Information in Pickering ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

Needham, J. (1978)
Short History of Science and Civilisation in China, Cambridge University Press, Cambridge.

New Drug Approved by the Chinese Authority 1986-87, Chinese Pharmaceutical Affairs, 2(1):66-72.

Newton, D. C. (1990)
From Patchwork to Network, Patent Information Dissemination in UK, World Patent Information, 12(1):15-19.

Nolan, M. P. et al. (1980)
Patenting, Profitability and Marketing Characteristics of the Pharmaceutical Industry, World Patent Information 2(4):169-176.

OECD (1981)
Science and Technology for the 1980s, OECD, Paris.

Online Business Source Book 1990, Headland Press, London, 1990.

Online Business Source Book 1991, Headland Press, London, 1991.

Pickering, W. R. ed. (1990)
Information Sources in Pharmaceuticals, Bowker-Saur, London.

Potter, G. W. (1981)
Lotka's Law Revisited, Library Trends, 21-37, Summer, 1981.

Prentis, R. A., Walker, S. R. et al. (1988)
Pharmaceutical Innovation and R&D Investment in the UK, Managerial and Decision Economics, (9): 197-203.

Prentis, R. A. et al. (1988)
Pharmaceutical Innovation by the 7 UK Owned Pharmaceutical Companies (1964-1885), Br. J. Clin. Pharmacology, 25:387-396.

Price, D. J. de S. (1963)
Little Science Big Science, Columbia University Press, New York.

Price, D. J. de S. (1986)
Little Science Big Science and Beyond, Columbia University Press, New York.

Ramsden, H. & Ramsden, S. (1990)
The Use of Information Technology By Information Services, Aslib, London.

Revill, J. P. (1984)
Drug Information Sources 2nd ed., Gothard House Publication Ltd., Oxon.

Rose R. (1982)
United Kingdom Facts, Macmillan Press Ltd. London.

Royal Society (1981)
A Study of the Scientific Information System in UK, BLRDD Report No. 5626, London.

SRIS Information Package 1990, London, 1990.

Sengupta, I, N. (1974)
Choosing Pharmacology Periodicals, Annual Library Science Documentation, 21(1-2): 1-21.

Shao, Y. N. (1988)
Health Care in China, Office of Health Economics, London.

Shen, J. L. (1990)
Use of Patent Information Both Legal and Technical In China, World Patent Information, 12(4):242-244.

Shen, J. L. (1985)
Recent Development on the Documentation System in CPO, World Patent Information, 7(4):260-263.

Sidel, R. & Sidel, V. (1982)
Health of China, Zed Press, London.

Sigurdson, J. (1980)
Technology and Science in P. R. China, Pergamon Press, Oxford.

Simon, J. L. and Burstein, P. (1985)
Basic Research Methods in Social Science, 3rd ed. Random House, New York.

Smith, J. C. & McNulty, H. (1982)
National Drug Information Network, Pharmaceutical Journal, 67-69, Jan. 16, 1982.

Smith, L. C. (1981)
Citation Analysis, Library Trends, 83-100, Summer, 1981.

Stephens, A. (1987)
Abstracting and Indexing Services Produced in UK, Journal of Information Science, 13:317-319.

Tang, T. B. (1984)
Science and Technology in China, Longman, London.

Tao, C. (1991)
Expenditure of Lan Zhou Library of Academia Sinica, personal communication, March 1991.

TCM 1949-1989, People's Health Press, Beijing, 1989.

Thorp, R. G. and Schur, H. (1988)
Foreign Language Barrier: A Study Among Pharmaceutical Research Workers, Journal of Information Science, 14:17-24.

Tianjin Medical Information Institute (1989)
Survey of Medical Scientists Information Needs, Medical Information Work Journal, (3):8-13.

UN World Economic Survey 1989/1990, United Nations, New York, 1990.

University Funding Council (1989)
University Statistics 1988-1989, Cheltenham, UK.

Vickery, B. C. and Vickery A. (1987)
Information Science in Theory and Practice, Butterworths, London.

WHO (1983)
Primary Health Care - the Chinese Experience, WHO, Geneva.

WHO (1988)
World Drug Situation, WHO, Geneva.

Walker, B. C. and Walker, S. R. (1988)
Trends and Changes in Drug Research and Development, Kluwer Academic Publisher, Dordrecht.

Walker, S. R. (1989)
Pharmaceutical Patents - The Stimulus to Medicines Research, CMR report, Surrey.

Walton, J. (1986)

Oxford Companion to Medicine, Oxford University Press.

Wang, T. J. (1987)
S&T Reform in China, S&T Information Work, (11):1-3.

Ward, S. (1990)
Performance of the Pharmaceutical Industry in Providing S&T Information, in Pickering ed. Information Sources in Pharmaceuticals, Bowker-Saur, London.

White Paper (1986) : China S&T Policy and Guide, State S&T Commission of China, Beijing, 1987.

White Paper (1987) : China S&T Policy and Guide, State S&T Commission of China, Beijing, 1988.

White Paper (1988): China S&T Policy and Guide, State S&T Commission of China, Beijing, 1989.

White Paper (1989): China S&T Policy and Guide, State S&T Commission of China, Beijing, 1990.

White, H. d. and Mccain, K. W. (1989)
Bibliometrics, in Annual Review of Information Science and Technology, 24: 119-186, Elsevier Science Publishers, Amsterdam.

Williams, G. A. et al. (1984)
Information Services in the Development and Use of Medicines, Pharmaceutical Journal, 233: 381-383, 500-502.

Williams, M. ed. (1987)
Drug Discovery and Development, Humana Press, Clifton, N. J.

Wilson, T. Head of dept. of library and information studies, Sheffield University, personal communication, 1990.

Wooster, H. (1979)
The Fuction of Scientific Publishing, in A. J. Meadows ed. Scientific Journal, Aslib, London.

World Bank (1985)
China Long Term Development, Johns Hopkins University Press, London.

Worlock, D. R. (1990)
Restructuring the European Information Industry, In the 14th International Online Meeting, London.

Wu, R. (1989)
China Medlars Centre, Medical Information Work Journal, (2):49-50.

Wu, Y. (1988)
Chinese Medical Journals, Medical Informatin Work Journal, (1):37-47.

Wuhan Hospital (1985)
Information User Study, Medical Information Work Journal, (4):18-25.

Xu, X. M. (1989)
Chinese Patent Information Service System, World Patent Information, 11(2):83-84.

Xun, D. (1988)
China Medical University Union Catalogue of Foreign Journals 1987, Medical Information Work Journal, (1):11-28.

Yan, C. (1988)
Top Ten Medical University Journals, Medical Information Work Journal, (6):32-39.

Yuan,G. (1989)
A Study on Pharmaceutical Analysis Journal, Medical Information Work Journal, (3):45-48.

Zeng, M. ed. (1990)
Database Developments and Chinese Information Needs, Proceeding of the 2nd International Symposium on Computerised Information Retrieval, Aslib, London.

Zhang, S. (1988)
Top 20 Medical University Journals, Medical Information Work Journal, (3): 50-56.

Zhang, Y. et al. (1989)
A Bibliometrical Study on Chinese S&T Literature in 1988, ISTIC report.

Zhang, Y. et al. (1990)
A Bibliometrical Study on Chinese S&T Literature in 1989, ISTIC report.

Zhao, M. (1991)
Patent and Tradmark in China, World Patent Information, 13(1):32-36.

Zheng C.S. and Pendleton, M. D. (1987)
Chinese Intellectual Proporty and Technology Transfer Law, Sweet & Maxwell, London.

Zheng, X. et al. (1989)
Review on the Postgraduate Education in Academia Sinica, Bulletin of Chinese Academy of Science, 4(3):234-238.

Zhong, K. (1990)
Statistcal Data on Chinese S&T Journals, Journal of Chinese Periodical Stuty, 1(1):21-21.

Zhou, S. (1987)
China's Patent System, World Patent Information, 9(4): 235-236.

Zhou, Z. (1987)
China's Online Services, ISTIC report.

Zhou, Z. (1991)
Professor of ISTIC, Beijing, personal communication, 1991.