significant number of researchers.

Today, CAS is experimenting with similar biweekly bulletins designed especially for the research interests of industrial customers, who pay not only for each bulletin purchased but support the developmental costs of preparing the computer profiles as well. Such alerting bulletins can be especially useful where traditional library support is not available.

The abstract is today the great untapped resource of the CAS data base, and much interest has been expressed in making this valuable source of information more available in computer-readable form and a basis for retrieval through computer searching of words contained in the abstract text. While all abstracts containing new chemical and chemical engineering information will continue to be published in *Chemical Abstracts* as the complete, archival record of the world's chemical literature, more emphasis will be placed in the future on finding new and more individually tailored services that make abstracts more accessible through the speed, accuracy, and flexibility of computer processing.

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A Comprehensive Audio Course on the Use of the Chemical Literature†

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Received March 17, 1980

The rationale for, development of, and organization of a comprehensive audio course on the chemical literature under the auspices of the Americal Chemical Society are described. The structure of the course is based upon an analysis of chemical information activities of individuals by Arnett (1970) in which types of searches (retrospective—exhaustive or reconnaissance—searches, data searches, current awareness) are matched to appropriate printed as well as computer-readable chemical information sources. The course features visual presentations of typical publication content, detailed descriptions particularly of secondary literature sources, and identification of user aids.

INTRODUCTION

An audio course entitled "Use of the Chemical Literature. An Introduction to Chemical Information Retrieval" (1978) has been released by the American Chemical Society, Department of Educational Activities. This paper gives the rationale for the preparation of this course, describes its genesis, and explains its organization.

The course physically consists of a set of eight audio tapes totaling 8.8 h of lecture, a manual consisting of 300 visuals and illustrations, and a set of 60 exercises to give students facility in using search tools. The course manual contains an index and may have some utility as an independent chemical literature reference tool.

The course is designed to prepare individuals to use the major search tools and even most minor ones required in chemical literature searches. It is intended to do this for individuals ranging all the way from inexperienced students to experienced users. A specific goal of the course is to provide a means of updating the literature searching skills of the latter group.

The course subtitle in part reflects the effort which was made not only to describe search tools and show how to use them but also to guide individuals in the development of search strategies.

BACKGROUND

In recent years, much of the academic instruction on the use of chemical literature in the United States and abroad has been informal. Typically, a small group of students is taken to the library, given a brief tour and some rudimentary instruction on secondary sources, and directly launched on searches.

Although I have conducted such introductions myself, I know how deficient they are. Since they are too often the only

† Presented to the Division of Chemical Information, Symposium on the Teaching and Use of Chemical Information in Academia, 178th National Meeting of the American Chemical Society, Washington, DC, Sept 10, 1979.

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1. John T. Dickman, Michael P. O'Hara, and O. Bertram Ramsay "Chemical Abstracts. An Introduction to its Effective Use" American Chemical Society	2.3 h
2. Patricia J. Delks "A Guide to Chemical Abstracts" Science Media	20 min
3. Martha M. Vestling and Janice T. Liebe, "A Guide to Beilsteins Handbuch" Science Media	22 min
4. Michael M. King and Linda S. King "A Guide to Searching the Biological Literature" Science Media	90 min

Figure 1. Other science literature audio courses.

form of instruction received on the topic, graduates commonly leave colleges and universities with a rather shallow knowledge of the chemical literature.

In 1974, I was asked to give a minicourse on chemical literature to doctoral students at the City University of New York. Six hours of time was allocated for this purpose. The course was attended by students, faculty members, and librarians.

In preparing the minicourse, I consulted available guides to the chemical literature.[1-3] Suprisingly, in 1974 there was only one up-to-date guide available. Consequently, much of the course content was developed through an independent analysis of search tools.

Significantly, in 1979 two new guides[4,5] became available and one standard chemical literature text was revised.[1b] The publication of three guides to chemical literature in 1 year is remarkable and is probably not totally accidental. It is suggested that their appearance reflects a heightened interest in the formal instruction of chemical literature usage.

RATIONALE

A minicourse is but one solution to the need for *systematic* instruction in chemical information retrieval. An alternative solution was sought which would (a) facilitate the sampling of a wide variety of search tools outside the library, (b) not be constrained by the limitations of any one library, and (c) reach a larger audience.

This led to the creation of an audio course whose format also permits self-study. This is an instructional mode which I believe is appropriate here, since learning how to carry out chemical literature searches is not conceptually difficult and the time required to learn how to carry out searches is not very long. Moreover, for those only requiring updating, a self-study course clearly is an appropriate format.

The audio course required the preparation and logical organization of comprehensive and up-to-date instructional materials, that is, materials which describe the literature and search tools as they actually are; the materials had to be thoroughly illustrated; and it was important that they be backed up by exercises.

Although the use of numerous illustrations greatly improves the instructional process, it does not do away with the need to consult a library. It is actually not unreasonable to learn about the chemical literature *in* a science library. At very least, such learning must be accompanied by considerable browsing and handling of search tools. This is as true for self-study as it is for a course taught by an instructor.

Others have also evidently felt that self-study is a suitable format to learn to use the chemical literature. Figure 1 lists several pertinent audio courses or tape and slide courses that have recently become available. All of these are commercial ventures and, except for the last one, are courses limited to only one search tool. Other audio courses and video tape courses on the topic have been prepared for in-house use or for promotional purposes, but they are not as well known or available for general use.

1. Comprehensiveness
2. Uptodateness
3. Extensive use of illustrations
4. Identification of user aids
5. Modules

Figure 2. Course characteristics and format.

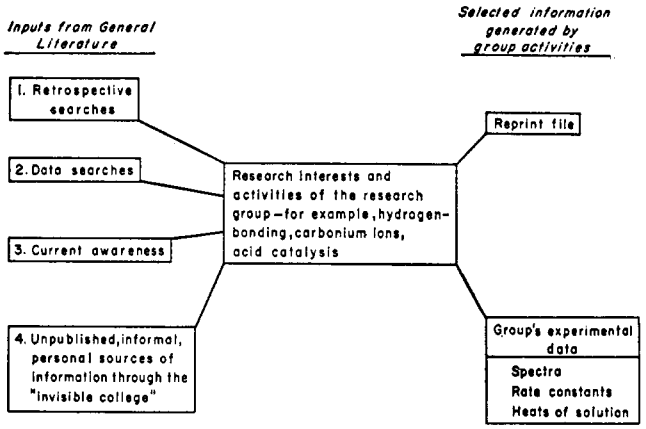

Figure 3. Chemical information activities of a research group. Reproduced with permission from ref 6. Copyright, 1970, American Association for the Advancement of Science.

COURSE CHARACTERISTICS

Figure 2 outlines the desired characteristics that determined the format and content of the audio course. The latter was created by thorough revision of the minicourse mentioned earlier.

The first of these characteristics is comprehensiveness. For a course encompassing the entire chemical literature, it was important that it incorporate material on all major and most minor search tools—what they are and how to use them.

An equally important second characteristic desired was that the course content be up-to-date. This is obvious, yet it actually proved to be a difficult task to implement due to rapid changes that were taking place in the secondary literature, even during the 4-year period in which the course was prepared.

The third characteristic, illustration, is essential for a self-study course and distinguishes it from chemical literature textbooks. Few of these actually show what is inside abstract journals, compendia, indexes, and the like. Yet it is important to make it possible for potential users to visually inspect typical contents of the works described. Moreover, detailed instruction in the use of complex search tools virtually requires highlighted illustrations to identify features discussed on tape.

The fourth characteristic, identification of user aids, will be discussed below. Rarely are such publications identified in chemical literature texts.

The last item of Figure 2 refers to the physical separation of topics (search types and search tools) in the course manual and the tapes, to allow these to be studied and reviewed independently of others.

ORGANIZATION

The structure of the course is based on an analysis and the organization of chemical information activities of individuals developed by Arnett.[6] This is outlined in Figure 3.

This organization is applicable to industrial as well as academic settings. At the core of the schematic is the scientific

I. Introduction
IIA. Searches through Secondary Sources
Retrospective Searches
1. Exhaustive Searches
2. Reconnaissance Reading
IIB. Data Searches
1. Compendia
2. Compilation of Constants and Physical Data
III. Primary Literature Sources
IV. Current Awareness
V. Tertiary Sources

Figure 4. Course ouline.

Use of abstract journals
Chemical Abstracts
CA organization
Comprehensive CA indexes
CA registry system
Collective indexes
Use of *Chemical Abstracts*–strategies
Current Abstracts of Chemistry and *Index Chemicus*
Chemical Substructure Index
Wiswesser Line Notation
Science Citation Index
Other abstract journals
Dissertation Abstracts
Review articles and how to locate them

Figure 5. Search tools for exhaustive searches.

work of an individual or group. This is surrounded by the associated information activities. The input is at the left and the output, some of it flowing into the chemical literature, is at the right. The course focuses on the input, that is, the information acquired from the chemical literature at the onset of the work and as it is proceeding. The principal inputs are identified according to search type, namely, retrospective searches, data searches, and current awareness.

The first two emphasize use of the library and the major secondary search tools: abstract journals, compendia, handbooks.

The third is more likely to take place at one's own desk with alerting journals, and through use of computer-readable sources and services.

The course organization is outlined in Figure 4. The outline suggests that the search types are matched to the chemical literature as it actually is, i.e., searches emphasize use of secondary literature sources which are treated first and in considerable detail. The secondary literature leads to the primary literature in searches that often require tertiary literature in their conduct.

The audio course stresses printed search tools over computer-readable ones, since I believe that these remain the most important for the time being. Many chemists, especially those in Academe, do not have access to computer-readable data bases because of the high cost of computer searches. Moreover, good searches can be carried out in the traditional way, albeit more slowly. Beyond this consideration, an audio course does not lend itself particularly well to illustrating searches by computer.

The core of the course is an examination of search tools for retrospective searches. Figure 5 identifies the tools required for exhaustive searches. The latter involve principally abstract journals and indexes, including *Chemical Abstracts* (*CA*), *Current Abstracts of Chemistry* and *Index Chemicus*, the *Science Citation Index*, *Dissertation Abstracts*, and even some of the foreign language and older abstract journals such as *Chemische Zentralblatt*, all of which are analyzed thoroughly. Their format is illustrated, their indexes are examined, and to some extent, they are compared to one another. Three tapes

Dictionaries
Encyclopedias:
Kirk-Othmer's "Encyclopedia of Chemical Technology"
Ullmann's "Encyklopadie der Technischen Chemie"
Specialized encyclopedias
Treatises and textbooks
Review articles
Monographs and how to find them

Figure 6. Reconnaissance reading.

1. Compendia useful in data searches
Gmelin's "Handbuch der anorganischen Chemie"
Beilstein's "Handbuch der Organischen Chemie"
Indexes to Beilstein
Technique-oriented compendia
Compilations of syntheses
2. Compilations of constants and other reliable physical data
"Landolt-Börnstein Tables"
"International Critical Tables"
National Standard Reference Data Systems
Specialized tables
Collections of spectra

Figure 7. Data searches.

totaling over 3 h are devoted to exhaustive searches.

This rather lengthy treatment is warranted by the complexity of these key search tools. In the case of *CA* alone, one needs to consider the several comprehensive indexes, the use of the "Index Guide", the role of the Registry System, the cumulative indexes, and the "Parent Compound Handbook", as well as approaches to the development of search strategies.

Subsequently, another major type of retrospective search is described (Figure 6), a briefer one to which Bottle has given the name *reconnaissance reading*,[7] which emphasizes the use of encyclopedias, treatises, review articles, and monographs. All of these search tools are critically examined. Considerable emphasis is placed on reconnaissance reading since such searches are quite common.

The second principal category of searches identified by Arnett is *data searches* (Figure 7) which emphasize use of the major compendia, namely, the "Gmelin Handbook" and "Beilstein Handbook", and compilations of constants and reliable physical data such as the "Landolt–Börnstein Tables", the older "International Critical Tables", the "National Standard Reference Data System", and collections of spectra.

The only types of primary literature discussed in any detail are those having special retrieval problems, notably, dissertations, patents, and government documents. The emphasis is on abstracts and index search tools designed to facilitate the use of these types of documents. Also discussed are problems associated with the acquisition of the documents themselves. Particular emphasis is given to the fact that dissertations and patents contain much information which does not find its way into the more accessible primary periodical literature.

The third major category of input shown in the Arnett schematic is current awareness. Here an overview is given of printed tools as well as computer-readable ones. The standard alerting journals *Chemical Titles* and *Current Contents* are considered first. These are contrasted to *CA Abstract Issues* and, in particular, *CA Section Groupings* for current awareness. Other printed works available by subscription such as *Macroprofiles*, *CA Selects*, and *Ascatopics* are also described.

The major available computer-readable files useful for current awareness and increasingly for partial retrospective searches are identified. Their use is described, and a brief introduction is given to the construction of search profiles. Detailed instruction in carrying out interactive searches is not

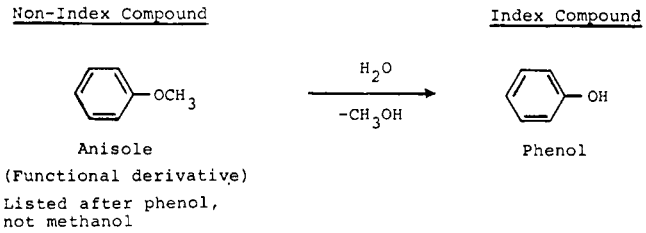

Figure 8. Index compounds and nonindex compounds in Beilstein.

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Springer-Verlag: Berlin and New York, 1978.
(g) "Beilstein Dictionary. German-English"
Springer-Verlag: Berlin and New York, 1979.
(h) "Landolt-Börnstein Outline"
Springer-Verlag: Berlin and New York, 1978.

Figure 9. User aids.

given, since quite often this is not done by chemists themselves but by librarians and other information specialists. For those who wish to carry out interactive searches themselves, specialized user aids are required such as the "CAS Search Aid Packages". (A video tape course would have an advantage over an audio tape course in the description of an interactive search of a computer-readable file, since the dynamics of such a search can be illustrated on video tape much more readily than by means of the static illustrations of a printed audio course manual.)

The course concludes with a description of those essential peripheral publications and services that facilitate searches and information retrieval in general. Such tertiary sources and services include lists of periodicals such as the "CAS Source Index", article and tear sheet services, lists of scientists, referral centers, and buyers' guides.

Throughout the course, liberal use is made of illustrations of the search tools described. Figure 8 illustrates part of an original schematic designed to help students to see and understand the relationship between *nonindex* and *index* compounds in the Beilstein Handbook. Some of these illustrations were designed as much for experienced users of the literature and librarians as for novices, to approximate browsing through unavailable publications in order to assess probable utility.

A number of user aids are identified in the course—booklets, pamphlets, catalogs—that are distributed very often free of charge by publishers. They may be available in libraries, but may have to be specifically requested. Use of such user aids (Figure 9) may be essential since they often provide more detailed information about search tools and give more detailed directions in their use than can possibly be found in any chemical literature guide.

It is remarkable that the number of user aids has increased substantially in recent years. In the past, publishers of major secondary search tools did not appear to be visibly concerned with user problems. The trend away from this attitude is quite commendable.

A set of exercises designed to illustrate virtually all search tools described except for computer-readable ones accompanies the course. The solutions are given and in many cases these identify alternatives which underscore the partial redundancy of secondary literature sources.

An analysis of the time required by undergraduates to complete the course and to work out the exercises has been made. It is estimated that ~60 h is the total time required. This analysis stresses the fact that without access to a library, corresponding to the laboratory component in a more typical chemistry course, the course would be less effective.[8]

It remains to be seen whether these exercises will achieve the purpose of reinforcing the aims of the course and give students facility in carrying out real chemical literature searches.

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NIH/EPA Chemical Information System

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Received December 13, 1979

A network of over a dozen interactively searchable chemical data bases has been made available for worldwide general use.

The NIH/EPA Chemical Information System (CIS) was started in 1973 as a joint project in mass spectrometry[1] and structure searching[2] between these two agencies and has, over the years, developed with the additional cooperation of other U.S. Government agencies,[3] as well as other organizations in the United States and elsewhere. A preliminary report of the