desired information. This problem has been solved in the Separations Systems Data Base by splitting the input of such reports into two or more entries, each of which contains only the index terms relating to a single subject. Each of the "splits" is a complete and separate record as far as index terms are concerned, but it does not contain the bibliographic information or abstract and simply refers back to the parent record for those. Cross coupling of unrelated index terms is thus effectively eliminated. An example of how such references appear in the output is seen in Figure 4. For this illustration, the index terms "URANIUM" and "IRON -" were used. Many of the references shown here are in progress reports that contain information on many other separations.

Material that is located in the data base can be displayed and/or printed in several formats ranging from a listing of accession numbers only, through brief bibliographic listings, to complete listings containing all of the index terms and the abstract.

The indexing of documents has been made simple and relatively painless by the use of an input form that contains the complete thesaurus for each field in addition to space for the abstract and bibliographic material (Figure 5). The indexer has only to circle the appropriate word or words in each section. An abstractor's manual that gives complete instructions for input to the data base is available.[2]

The data base contains approximately 4000 entries that include progress reports from a separations research group at ORNL (1945-1967). Also covered are about 20 journals pertinent to solvent-extraction and ion-exchange research in the period 1978-1982. This is a small but useful fraction of the available solvent-extraction and ion-exchange information. The data base presently has no funding to expand; however, the indexing structure of the data base has demonstrated definite advantages for those wishing to retrieve information on chemical separations and contains some features potentially applicable to data bases in other subject areas. Additional information on the data base can be obtained by contacting the authors.

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Unresolved Problems and Opportunities in Chemical Literature Teaching†

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The experience of an instructor in teaching a formal chemical literature course in academia is described. The effects of unresolved problems associated with such a course are assessed, including lack of brief yet effective exercises, time limitations, and unavailability of key search tools in libraries. In the larger context, the causes and consequences of widespread lack of formal instruction on the chemical literature are discussed, as well as factors such as unavailability of user aids in libraries, professor-librarian interaction, the need for improvement in key search tools, overemphasis on instruction in the use of machine-readable files, and the issue of informal vs. formal instruction of chemical literature usage.

INTRODUCTION

This analysis of the teaching of chemical literature usage is based largely on experience gained through the delivery of a formal chemical literature course over the past 4 years.[1] This course is, in turn, generally organized along the lines of the American Chemical Society Audio Course "Use of the Chemical Literature", whose genesis and content have been described previously.[2,3] An important feature of this course is the requirement that students carry out a set of exercises dealing with all facets of the chemical literature.

COURSE PROBLEMS

Problems associated with the course are identified here in the belief that they are of general interest in the conduct of any chemical literature course, and as introduction to the following section.

The unavailability of appropriate instructional materials for the course has been a problem since the beginning. Textbooks in this field[4] are very rapidly outdated and too often contain insufficient material to permit students to evaluate, and to learn, when and how to use the major secondary literature search tools. The problem of obsolescence can be overcome to some extent by use of specific user (search) aids (described in footnote 2). Without doubt, a combination of reading assignments would solve this problem if this could be done without overloading the students. The compromise achieved is admittedly unsatisfactory.[5]

The key to an effective chemical literature course is the assignment of realistic exercises involving the use of all major secondary search tools. The principal difficulty associated with these exercises is the time required to work them. Students have uniformly agreed that the exercises are essential; yet, most have felt that the time required to carry them out was ex-

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cessive. As a consequence, I have not felt it reasonable to assign a term paper or major retrospective search in the course, either of which would be desirable assignments in a chemical literature course.[6]

All published chemical literature exercise sets were examined.[7] Only one set of exercises was found that makes it possible for each student to be assigned an individual exercise of a given type.[8] Ten exercises, mostly illustrating the use of secondary sources, are assigned with the last one being a hands-on problem requiring the use of on-line files.

Although commercial exercise manuals dealing with on-line searching are available,[9] these were not used by the class. They were available for consultation in the library. Instruction in on-line searching presents the greatest challenge to the fledgling formal chemical literature course due to the relative inexperience of chemistry faculty with this medium, and due to rapid changes in the details of on-line searching.

The most effective means of teaching on-line searching was found to be over-the-shoulder demonstration, which is practicable with groups not exceeding about 10 students.

UNRESOLVED GENERAL PROBLEMS

The following is an analysis of general problems associated with chemical literature teaching.

(1) Unavailability of Search Tools. Typical complaints over inadequate library budgets focus on journal subscriptions and the cost of new monographs. However, when *teaching* needs are assessed, one must clearly differentiate between primary and secondary sources. The lack, or incompleteness, of major search tools (abstract journals and indexes, compendia, encyclopedias, review journals and series) is then much more serious than a thin collection of primary literature in one's library.[10]

While some of the lacunae are cost-related, not all are. In some libraries, it is the unfamiliarity of librarians with specific search tools and/or their relative importance that is responsible for the absence of a given work.[11] In some geographic locations, cooperative arrangements for purchase and use of library materials may mitigate financial problems that are particularly serious in small colleges and universities.[12] One additional suggestion for dealing with unavailable search tools is to obtain sample copies for examination and familiarization by both instructors and students.[13]

(2) Dispersal of Search Tools. This is a fairly common problem on campuses large enough to have branch libraries housed in different buildings. Such dispersal may be more serious in discouraging regular users of library materials to take advantage of a specific search tool than in precluding the assignment of an exercise in a chemical literature course.[14] Nonetheless, such dispersal, when it is necessary in the context of chemical literature, is best undertaken following consultation between librarians and chemistry faculty.

(3) Unavailability of User (Search) Aids. This refers to booklets, pamphlets, and wall charts designed to assist novice and occasional users in the use of specific search tools. Typically, user aids are provided free by publishers.[15] The preparation and dissemination of these ancillary tools is a positive and relatively recent feature of the chemical literature "scene". However, their presence in chemisry or science libraries is far from being uniform. Often, this may be due to the lack of awareness of their existence and availability on the part of responsible librarians. Instructors of chemical literature courses and others concerned with less formal instruction in chemical literature usage must make a point of seeking out user aids and should insist that they have a prominent place in libraries. Carefully mounted wall charts (in permanent containers or behind plastic) that demystify the content and use of major search tools encourage students to use the latter and suggest that those in charge of the library have the users very much in mind.

(4) Professor–Librarian Interaction. This heading refers to a dynamic interaction that should be nurtured if the library is to play an optimal role in the activities of students and faculty of a chemistry department. Many departments have formal mechanisms (a committee or a representative) for dealing with this. Instructors of chemical literature usage have a special reason for cultivating a good relationship with their librarian colleagues. Indeed, this may even raise the issue of the joint teaching of chemical literature courses by librarians and chemists. This option may be desirable. Local circumstances and the relative expertise and interests of the individuals involved ought to determine whether the course would benefit from being taught jointly by a librarian and a chemist. Without digressing too far, it is a fact that in some institutions such courses are taught by the librarian. And in institutions in which the instruction is informal, it is often the librarian who does the job entirely.

All other things being equal, who should teach chemical literature courses, librarians or chemists? I submit that a chemist is better suited to this task since only one who uses collection actively is likely to instruct novices in such use most effectively. There is also a psychological aspect to this; students of the chemical literature will more readily recognize the worth of such a course when one of the chemistry faculty teaches it.

The preceding personal point of view may sound condescending to librarians. This, however, is not at all my intention. Librarians are usually generalists.[16] Only the largest of chemistry libraries have librarians who have had formal training in chemistry beyond the undergraduate level. It is then not even reasonable to ask them to carry the principal burden of instruction in the use of the chemical literature.

(5) Need for Improvement in Key Search Tools. Literature search tools are not inviolate or unchanging. Rather, they are evolving documents. This is as true in the library as it is in the laboratory with respect to instruments or devices. Teachers of chemical literature courses as a group would seem to be among those best able to suggest changes and improvements in existing search tools—particulary the major secondary ones—to their publishers. There is some evidence that publishers, particularly those associated with professional societies and other nonprofit organizations, are responsive to a dialogue having as its goal the improvement of the search tool itself or the creation of new user aids. This represents an opportunity that all instructors of chemical literature courses should pursue.

(6) Overemphasis on Instruction in the Use of Machine-Readable Files. It is a perception on my part that there is some overemphasis on instruction in the use of machine-readable data bases and of on-line searching in chemical literature courses. For the novice, in particular, a balanced introduction to printed sources on one hand and to computer searching on the other is most appropriate, with the limitations and strengths of each approach clearly identified.

Teaching students about on-line data bases is appealing and still relatively novel, perhaps even fashionable, in the context of chemical literature courses. This can easily lead to giving disproportionate attention to this aspect of the chemical literature of the expense of printed search tools.[17]

Students quickly learn that searching machine-readable data bases can be a highly efficient process. At first, it may even be exciting. Yet for specific types of information, such as a given physical datum, searching on-line may be ineffective.

This perception about the balance of instruction in two complementary methodologies is not to be construed as an attack against on-line searching. The latter is powerful and time saving. Moreover, computer searching uniquely allows full structure and substructure searching to be carried out, completely sidestepping the need to use systematic chemical names. And, machine-readable files allow the use of combined search terms by incorporating Boolean logic in the software.

On-line data bases are sometimes represented as being *the* solution to chemical literature needs of professionals. This effectively constitutes pressure for the use of such data bases. It is the responsibility of instructors of chemical literature courses to guide students in the choice of appropriate search tools. Students will gradually discover that literature searches of all types require a balance between the traditional search tools found in a library and those involving computers and data bases located elsewhere.

It has also been my experience that a good understanding and appreciation of the nature, strengths, and limitations of machine-readable data bases can more readily be gained when printed publications are treated first and in depth.[18]

(7) Informal vs. Formal Instruction. Should the use of the chemical literature be taught in a full credit-bearing formal course, or should this topic be taught informally? This is one of the key unresolved problems in chemical literature instruction. The majority of chemistry departments in the U.S. and elsewhere would seem to have decided the issue simply by not offering formal chemical literature courses.[19]

Clearly, not all chemistry faculty are convinced of the need of such a course, especially those in the research universities. One must add that these are the very institutions that have the strongest library resources and capabilities and where professional librarians, typically, are present in the very buildings where the chemists work. This juxtaposition permits the perpetuation of an attitude of disdain of chemical literature courses: the chemistry librarian can "take care" of whatever little instruction is required, and the same individual can assist with any troublesome searches needed by faculty or students.

The above explanation is no doubt too facile, and as I am well aware, it does not accurately describe what takes place in all leading universities that have strong chemistry departments. Nonetheless, some of the elements described are valid and are in stark contrast to what obtains in the smaller colleges and universities that constitute the majority of institutions in the U.S. It is significant that the latter are more likely to deal with the instructional needs through formal chemical literature courses in spite of the typically smaller chemistry faculties available.

For the moment, relatively few students receive thorough instruction on the nature and use of even as basic a tool as *Chemical Abstracts*. Even fewer get to know and to use effectively major works such as the *Beilstein* and the *Gmelin Handbooks*. I am forced to conclude that many chemists do not feel that this is a serious problem and that students will somehow cope during their school years and beyond.

A possible difficulty not earlier identified is the lack of "experts" to teach chemical literature courses in typical chemistry departments.[20] In principle, every chemistry faculty member should have sufficient experience in carrying out literature searches to be able to teach a chemical literature course with modest preparation. The only possible explanation to the contrary would seem to be that many academic chemists do not, in fact, know the major secondary search tools—as they exist today—well enough. I submit, however, that just as for any subject, intelligent individuals can learn the necessary material without hardship. Efforts to find volunteers willing to prepare such a course should be undertaken in all departments.

Few areas in the chemistry domain are as pervasive as the chemical literature itself. Yet, until 1983, the American Chemical Society Committee on Professional Training (CPT) had not taken a strong position on the matter of formal training in chemical literature usage. However, CPT has now come out squarely in favor of formal instruction in information retrieval, whether in a separate course or spread out over several courses.[21] The recommendation also stipulates that library exercises be included as part of such instruction.[22]

For institutions unable to offer a full course, the second of the alternatives is an appealing partial solution. For example, incorporation of a limited number of formal lectures on the chemical literature in laboratory courses such as that in organic chemistry is not logistically difficult. Such lectures would need to be coupled to library exercises, and with the assignment of mini-literature searches pertinent to the laboratory experiments. Moreover, examination questions on the chemical literature during and at the end of the semester should be regularly assigned. Under these circumstances, the core of a formal literature course could be presented in 5–6 h to the majority (if not all) of the chemistry majors. Experiments along these lines have already been tried, with promising results.[23]

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(1) This course (1 h/week, 1 credit) is required only of students in the Industrial Chemistry option at City College. For others, it is an elective. The prerequisites are completion of general chemistry and one semester of organic chemistry (lecture). Most course participants have been juniors and seniors.
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(3) Walters, J. P.; Tylec, D. E. *Anal. Chem.* **1979**, *51* (12), 1233A.
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(5) Reading assignments were limited to available user aids (on *Chemical Abstracts*, the *Beilstein* and *Gmelin Handbooks*, and the *Landolt-Bornstein Tables*). The ACS audio course manual served as a reference tool.
(6) Satisfactory completion of the course and assignment of a grade are determined solely by performance in these exercises.
(7) These are as follows: "CAS Printed Access Tools"; Chemical Abstracts Service: Columbus, OH, 1981; Bottle, R. T., Ed. "Use of the Chemical Literature", 3rd ed.; Butterworths: London, 1979; Appendixes 1 and 2. Mellon, M. G. "Chemical Publications. Their Nature and Use", 5th ed.; McGraw-Hill: New York, 1982. Wilen, S. H. "Chemical Literature Exercises", ACS Audio Courses; American Chemical Society: Washington, DC, 1978.
(8) Gorin, G.; Dermer, O. C. "Library Exercises in Chemical Literature"; Chemistry Department of Oklahoma State University: Stillwater, OK, 1981. See Gorin, G. *J. Chem. Educ.* **1982**, *59*, 991.
(9) "CA SEARCH for Beginners"; Chemical Abstracts Service: Columbus, OH. "How to Use CA SEARCH"; Chemical Abstracts Service: Columbus, OH. These manuals no longer appear to be available.
(10) For example, my own library at City College lacks the following: *Current Abstracts of Chemistry and Index Chemicus, Science Citation Index* cumulative indexes, *CAS Source Index*, and *CAS Parent Compound Handbook*.
(11) A recent attempt to define a core chemistry library collection for an undergraduate program is Brasted, R. C.; Clapp, L. B., Eds. "Guidelines and Suggested Title List for Undergraduate Chemistry Libraries"; ACS Division of Chemical Education of the American Chemical Society: Washington, DC, 1982; revised.
(12) While I am unfamiliar with existing arrangements, I would be pleased to learn the specifics of any and how well they work.
(13) This suggestion was made by A. W. Kozlowski in connection with her paper "An Upper Level Survey Course in the Literature of Chemistry" presented at the Symposium on Chemical Literature and Information Retrieval in the Chemistry Curriculum, 184th National Meeting of the American Chemical Society, Kansas City, MO, Sept 15, 1982; Abstr. CHED-62.
(14) For example, because of its interdisciplinary character, the *Science Citation Index* and/or its cumulative indexes are often housed elsewhere than in the Chemistry Library.
(15) A partial list is give in reference 2.
(16) The concept of librarians and other chemical information specialists as surrogates is discussed by Maizell (Maizell, R. E. "How to Find Chemical Information"; Wiley: New York, 1979; p 2), who points out that such individuals are usually generalists.
(17) An entire chemical literature course has been organized around on-line searching with the premise that students who *begin* with such a search and are stimulated by the on-line medium will subsequently acquire skills in the use of other library materials: Howard, J. G.; Zuckerman, J. J. "Instruction in the Use of On-line Bibliographic Retrieval Systems.

An Experiment with Undergraduates", Symposium on Chemical Literature Searching in the Undergraduate Curriculum; Second Chemical Congress of the North American Continent, San Francisco, CA, Aug 25, 1980; Abstr. ACSC-7. See also, "Focus in *CAS Report*"; Chemical Abstracts Service: Columbus, OH, 1984; No. 15, Jan.
(18) Gaus, P. L.; Borders, C. L., Jr.; Powell, D. L.; Surbey, D. *J. Chem. Educ.* **1983**, *60*, 1048. See also reference 22.
(19) Approximately 35% of U.S. colleges and universities offer a formal course in chemical literature. This percentage has been constant for about 20 years; moreover, the total enrollment appears to be small: Ramsay, O. B.; Colman, R. P. "Status of Academic Instructional Programs in Chemical Literature and Chemistry Information Retrieval", Symposium on Chemical Literature and Information Retrieval in the Chemistry Curriculum; 184th National Meeting of the American Chemical Society, Kansas City, MO, Sept 15, 1982; Abstr. CHED-48. Sarkisian, J. E. "The Status of the Teaching and Use of Chemical Information in Academe", Symposium on Teaching and Use of Chemical Information in Academia; 178th National meeting of the American Chemical Society, Washington, DC, Sept 10, 1979; Abstr. CINF-1. See also Powell, A.; Schlessinger, B. S. *J. Chem. Educ.* **1971**, *48*, 688.
(20) Kirschner, S. "Chemical Literature Information Retrieval Instruction in Departments without an Expert", Symposium on Chemical Literature and Information Retrieval in the Chemistry Curriculum; 184th National Meeting of the American Chemical Society, Kansas City, MO, Sept 15, 982; Abstr. CHED-51.
(21) *Chem. Eng. News* **1983**, *61, No. 46*, 54.
(22) "Undergraduate Professional Education in Chemistry: Guidelines and Evaluation Procedures", ACS Committee on Professional Training; American Chemical Society: Washington, DC, 1983; pp 13, 19.
(23) Experiment undertaken by S.H.W. and E. L. Eliel at the University of North Carolina, Chapel Hill, NC, beginning Jan 1983. Similar programs operate at Central Connecticut State College, New Britain, CT; at the Hebrew University, Department of Organic Chemistry, Jerusalem, Israel; and at the University of Rochester, Rochester, NY. See Kozlowski, A. W.; Shine, T. D. "Library Labs for Sophomore Organic Students", Symposium on Chemical Literature Searching in the Undergraduate Curriculum; Second Chemical Congress of the North American Continent, San Francisco, CA, Aug 25, 1980; Abstr. ACSC-4 and Wolman, Y. "Integrating Chemical Literature and Information Retrieval into the Chemistry Curriculum at the Hebrew University"; Abstr. CHED-61 [see also, Wolman, Y. "Chemical Information: A Practical Guide to Utilization"; Wiley: New York, 1983] and Somerville, A. N.; Kende, A. S. "Computer Searching in the Chemistry Curriculum"; Abstr. CHED-63, both papers presented at the Symposium on Chemical Literature and Information Retrieval in the Chemistry Curriculum, 184th National Meeting of the American Chemical Society, Kansas City, MO, Sept 15, 1982. A more general description of the program at the University of Rochester, "Information Searching in the Chemistry Majors' Curriculum", Abstr. ACSC-5, was presented by the same authors at the San Francisco meting cited above. Yet other programs of instruction in use of the chemical literature integrated with the normal curriculum were described at the San Francisco Symposium.

Measuring Incremental Costs of Information†

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An attempt was made to establish a rational basis for information services budgets within a medium-sized specialty chemicals firm. Year-to-year comparisons of expenses for personnel, books, computing, and subscriptions showed that, over a 6-year span, the percentage contribution of computing costs to overall expenses increased dramatically while all other categories remained constant or decreased. Because assignments and responsibilities for the information services function changed significantly during the study period, incremental costs could not be calculated. Factors that influence the cost of information are discussed.

Earlier attempts at measuring the cost of providing information in industry[1,2] have both highlighted the inherent difficulties and shown great variability in results. The measurements taken for this study have led us to the conclusion that incremental figures are not meaningful for our situation, for reasons detailed below. This paper is presented, then, to help others in similar situations to better quantify their own programs.

By "incremental costs" we mean the increased resources needed to support new employees or, more appropriately, new customers or users of Technical Information Services (TIS). This implies that, at some time, there was a stable base of users and a basic set of services from which all measurements are made. Since the cost of services should be known, a simple calculation would give the cost per user from which changes could be observed. Unfortunately, not all employees are users, even though TIS has a corporation-wide charter, so fixing the denominator of the calculation is difficult.

The Technical Information Services group at Henkel resides physically and organizationally within the Research and Development Division (currently called "The Technology Group") and is the only technical information group in Henkel. Its corporate scope, however, requires involvement in nontechnical or business information—finance, marketing, personnel, legal, etc. Traditionally, the budget for TIS expenses has come entirely from the Technology Group no matter who was served. For Fiscal 1983, however, we began to allocate the "nontechnical and non-Minneapolis" information expenses. Of course, those who received the new allocations raised questions about actual costs, which initiated the present study. We hoped that a measure of incremental costs would also help us to respond to additional demands for services imposed by the acquisition of existing chemical firms. Finally, we sought a reasonable model on which to base subsequent budgets.

Our first approximation of information costs was based on a look at our past. In the 5 years from 1978 through 1982, the TIS group had grown from a staff of 5 (three professional, two clerical) to 11 (seven and four, respectively), and our annual expenditures had tripled. We began our analysis by dissecting our annual expense reports to see if our hunches about where this money was going were accurate.

Since it is commonly held that personnel costs account for the largest portion of services budgets, we compared people costs (wages, salaries, and fringe benefits) to total expenses from 1978 forward (Figure 1) and then calculated their percent contribution (Figure 2). The overall flatness of the slope in Figure 2 (52% in 1978, 50% in 1982) was surprising in light of the addition of six staff members during the 5 years.

Three other major contributors to TIS costs were identified: collection development (books), on-line and other time-sharing expenses, and subscriptions. A final category, "all other", was added, and the percentage contributions were calculated

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