TRAINING OF LITERATURE CHEMISTS

A collection of papers comprising the Symposium on Training of Literature Chemists, presented before the Division of Chemical Education and the Division of Chemical Literature at the 127th national meeting of the American Chemical Society, Cincinnati, Ohio, March 1955

Number seventeen of the Advances in Chemistry Series
Edited by the staff of *Industrial and Engineering Chemistry*

Published June 1956 by
AMERICAN CHEMICAL SOCIETY
1155 Sixteenth St., N.W.
Washington 6, D.C.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.fw001

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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Introduction

A former chairman of the Division of Chemical Literature of the AMERICAN CHEMICAL SOCIETY, J. W. Perry, in discussing the place of the literature chemist, [Chem. Eng. News, 28, 4530 (1950), Careers in Chemistry and Chemical Engineering], has stated: "The majority of them are engaged in ensuring that recorded chemical knowledge is used in the most effective way possible. Others are engaged in such diverse but related activities as writing and editing reports and papers, preparing and indexing abstracts, and managing chemical libraries."

Training enough individuals adequately for these important professional assignments is still an unsolved educational problem. I have taught a course on chemical literature for over three decades and one on chemical writing for some ten years. However, only a few universities and colleges have such courses, and almost none have a curriculum designed specifically for training literature chemists. Part of the problem, of course, is to arouse interest of students in the possibilities for such work.

In selecting authors for the papers in this symposium the chairman intentionally chose the same number of men and women. The work of the literature chemist seems particularly appropriate for at least part of the girls currently majoring in chemistry.

The range of the authors' experience in chemical literature seems appropriate for the topic discussed. Two of them come from large chemical industries; one is from a consulting laboratory requiring extensive library work; one teaches a course on chemical literature in the department of chemistry in a large university; one is a member of the staff of one of our best known library schools; and one is the editor of our indispensable Chemical Abstracts. In one way or another, each one has dealt with the problem of training literature chemists. From these diverse viewpoints we may expect worth-while evaluations of the present situation and suggestions for its improvement.

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Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch001

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

The Problem of Literature Chemists in Industry

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Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch002

Literature chemists are those who, because of their interests, education, and experience, have chosen to work with the literature of chemistry and its cognate fields. Chemical librarians, literature searchers, translators, reports editors, abstracters, indexers, bibliographers, and documentalists may be included in this category; all require a background of chemistry for the expeditious completion of their assignments. Diversified opportunities exist in the chemical industry but, since 1940, the problem of finding literature chemists with adequate qualifications and necessary skills has been acute. The situation had not improved by 1955; the outlook for the next 15 years is still worse, unless a greater number of students choose this career, which offers unusual opportunities for creative use of specialized interests. Closely allied with the problem of an insufficient number of qualified specialists are the questions of responsibility for training, adequate compensation, organizational status, performance standards, and the need of unified professional attention to all phases of the problem. Suggestions for remedying the problem are offered.

Who are literature chemists and what do they do? For the purpose of this paper they are designated as those who, by virtue of their interests, education, and experience have chosen to work with the literature of chemistry and its related fields. Chemical librarians, literature searchers, translators, reports editors, abstracters, indexers, bibliographers, and documentalists are among those included in this category. In fact, the patent attorney, the market research analyst, the advertising copy writer, and the technical editor, if and when their work is closely allied with chemistry, might also be included with little broadening of the classification. All require some experience with chemistry to benefit from the initial advantage of familiarity with assignments, as well as to reach maximum proficiency quickly. All, too, are concerned with communicating information to others.

In addition to these two relationships, there also may be a sort of academic cross-fertilization in educational background, resulting in the combination of subject knowledge of the particular field in which these specialists practice and familiarity with at least one other specialty. The editor must have a background of journalism, even though he is familiar with chemistry; the market analyst must know his literature sources, even though his degree is in economics; and the translator, a specialist in foreign languages, cannot produce technically correct results without knowledge of the subject in which he is working. In fact, some of these specialists need to know their way around in at least two other disciplines in order to achieve professional competence. In contrast to the laboratory chemist who enjoys a monogamous marriage to his science, one might paraphrase the

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

words of a recent author by saying. "All literature chemists practice cultural polygamy"(4).

The ensuing discussion is limited to the positions with job titles outlined in the first division of the classification. Their contiguous fields of activity often overlap. In many instances the duties inherent in these titles are combined and assigned to one person. Because informational materials are usually housed in the library, it can be assumed that the work will be carried on there. The scope of this paper is further limited to manufacturing organizations. Industry is interested in securing talent to perform work efficiently and finds it increasingly necessary to dissipate effort in locating qualified applicants. To secure 10 new employees, it is estimated that interviewers must see at least 200 prospects(5). In locating a qualified literature chemist, the amount of time expended on interviews and in correspondence is usually doubled and often tripled.

The work of literature chemists has been adequately described in print; therefore a detailed outline can be omitted here. However, the compensations of their work need emphasis. For example, because these employees are more career-minded than the average industrial worker, they appreciate the opportunity to participate in creative work, whether it be the devising of a special classification for antibiotics or organizing an information center. They like to grow professionally and to keep abreast of scientific advances. To many comes the inner satisfaction of contributing to the advancement of science itself. Though results cannot be measured in dollars and cents, literature chemists possess a great potential for information coordination in industry. Owing to the impact of communications from every direction, they are often more nearly aware of what is happening in their own companies than are the men in the laboratories working on single group projects. As for the future, if the proposal of a British professor of engineering is studied seriously, the information function may be added to the six major activities of industrial organizations, which now are the same as Fayol conceived them a half century ago, instead of continuing the plan of training functional specialists in each(6).

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The Problem

With stimulating and interesting work assignments why should there be any problem? There is and it is considered in six aspects: the first three separately and the last three in combination with actual situations in industry. One aspect of the problem is re-emphasized later. Five of these broad classes — Recruitment of chemistry students, Selection for advanced training, Education for literature work, Placement of qualified persons in congenial positions, and their Support after employment — represent possible phases of the process through which literature chemists find their first positions and are thus enabled to continue their careers. The sixth class — Performance — relates to the particular service they render in spite of the fact that there are no universally recognized goals. Additional questions and suggestions are brought up at various points in the discussion; they seem to defy classification.

Recruitment. Unfortunately, statistics are not available for citing the supply and demand for literature chemists, nor has any agency started collecting them. However, the Joint Committee on Library Education of the Council of National Library Associations received and discussed a proposal for such a survey at its meeting in New York, N.Y., April 15, 1955. However, basic to the recruitment of literature chemists is maintenance of a continuing flow of students who choose to become chemistry majors. Currently the alarming decrease in the number of young people preparing for professional careers in chemistry is demonstrated at one of our larger universities where, out of an original enrollment of 4,000 in freshman chemistry, only 18 earned B.S. degrees in this subject field. In another school, having 35 chemistry graduates, less than half planned to follow chemistry

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

as a profession (2). Coupled with the dwindling supply of students is an approximate 50% reduction in the number of certified science teachers (8). Therefore, it is only if and when the over-all number of chemists increases that more literature chemists will be available.

Selection. Because choice of a career is not the result of a single decision, literature chemists share more responsibility than they realize, not only for recruitment of students but for their selection by schools as candidates for degrees. Though not more than one in 20 precollege students has chosen his career, it is impossible to overestimate the interest that can be generated among potential chemistry majors by inviting selected groups of these students to visit industrial libraries and other work areas. Summer employment and work-study programs, offered to carefully chosen college chemistry students, are effective means of demonstrating that literature work offers opportunities for creative effort as well as for material advancement. Insight thus gained may result in enthusiasm which they may pass on to others — their fellow students and their professors. This is particularly true if the student applies for admission to a library school, where the quality of his undergraduate work may not be known first hand.

Education. In the early days of World War I, when chemical literature began its explosive expansion, the supply of literature chemists became short. Pleas have been made to both departments of chemistry and schools of library science to provide special training. The three formal prewar courses in chemical literature offered in departments of chemistry have multiplied considerably, but in a great many schools the subject is completely neglected. That appeals have not gone entirely unanswered by library schools is evidenced by recent curricular revisions in several, which now provide courses in the bibliography of science in addition to the elective plans a few schools offered prior to 1952. Courses in documentation have recently been established in some of them but it is hoped that there will not be a mushroom growth of these on a countrywide basis — in response to pressure for the "4 R's" — namely, the Recall, Retrieval, Resurrection, and Regurgitation of Information. This word of caution is provoked by a survey of the academic background of library school faculties, which disclosed that the natural sciences accounted for less than 10% of their majors while just 5% of the faculty members had had experience in special libraries(1).

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Abstracts of Case Situations

Queries were sent to 28 employers of literature chemists in various types of chemical companies scattered on a broad geographical basis. Each was asked for a summary of recent experience in locating a person to fill a vacancy. Only two had had no need to employ such a person within the past 3 years. Many generously described multiple attempts to find replacements and, among the 22 positive responses, several fell into a typical pattern; these are summarized collectively with particular emphasis upon what can be done toward solving the problem. It was also possible to select eight examples, all of which introduce at least one aspect of the various difficulties which may be considered today. These are presented anonymously in a series of abstracted case situations. Having tapped the ideas of others, the writer received almost more comments than she could possibly do justice to in a limited amount of time but, for the purpose of pinpointing several examples, and thereby encouraging discussion, personal comments have been interpolated following each of the abstracted replies.

I. The technical editor of an organic chemicals firm, in reviewing past difficulties, stressed the pirating of personnel among AEC contractors. He told of filling a chemist-editor's position by compromising for a biologist who had once prepared army parts manuals, only to have him snatched away by a competitor in less time than the 9 months it had taken to fill the position! He likewise deplored the personnel turnover in the library and related how the responsibility for it finally devolved upon the reports file super-

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visor, an ex-WAC seeking security. On the optimistic side he felt they were more successful in turning a biologist into an abstracter after a year of concentrated army type training

Comment. Little did this writer suspect, when consideration of the subject began, that piracy constitutes one facet of this problem. But here it is! Do we need more than a personal code of ethics to combat what we trust is an atypical situation? Obviously this case also illustrates that compromises are expedient when there is a dearth of qualified personnel. Does it also suggest a need for outlining specific academic qualifications that may be referred to in filling a vacancy, if and when applicants are more plentiful? While these need not be rigid, they would serve as guide lines for educators and students, provided they could receive general acceptance among the administrators of literature groups. Regardless of the fact that each industrial organization will operate independently, might it be worth while to exchange job descriptions for use in preparing staff manuals? Possibly company job analysts would also appreciate seeing them. Although the comment has been heard that standards of accomplishment are incompatible with the professional aspect of a position, the total lack of yardsticks is a real handicap. So, while chemistry is the common denominator that brings this group together, there may be some uncommon ones which would aid materially in solving the problems under discussion.

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II. From the head of literature service of a fine chemicals organization came exact details and statistics on company experience in filling six positions. For one in particular, which has been open almost 2 years and still is not filled, a copy of the advertisement which appeared in three publications accompanied the report. While most of the 48 librarians replying were qualified as "to scientific background and library administrative experience" set forth in the notice, many applicants were eliminated because of age (under 26 and over 42), foreign language deficiency, physical disability, personality problem, and finally the men because it was felt a woman would adjust more easily to the present staff. Of the nine whose applications were seriously considered, two were not interested in the location, one was disappointing at interview, and five eliminated themselves by accepting positions elsewhere or by becoming discouraged in waiting for interviews due to other negotiations in process. In the meantime two desirable candidates were recommended by colleagues. Three offers were made to applicants. One rejected the offer because the salary differential was insufficient in a higher cost of living area and the other two refused because they would be second in command in the over-all company library picture.

Comment. In regard to the second reason for rejecting the offers, while librarians must frequently accept responsibility for administration with little or no additional recognition, the arrangement might have worked out satisfactorily in this case without lowering morale. This organization expended much time in trying to fill openings, particularly the one for which it has been the most difficult to find the right person. Unfortunately, all employers seem to ask for approximately the same qualifications as to age and experience, so the meager supply of literature chemists does not stretch sufficiently for all. Recognizing this, a decision to revise the qualifications as to age and sex has been considered -- a realistic way of viewing the problem, although it does not ensure a solution. The salary offered was above average for the geographical area involved and equal to or more than the sum many heads of libraries receive. In this case the conclusion has been reached that the best methods of securing personnel are personal contact, college recruitment, and association placement services, in the order named. While a large number of answers to advertisements were received, they have not proved the most satisfactory method of locating applicants.

III. Late in 1954 the head of information service of a multiplant paper company asked for help in finding a young woman under 35, with a degree in library science and a minimum of 3 to 5 years' industrial technical library experience or the equivalent. He preferred that this person have ability in and inclination toward administration, a background in general science, and experience in subject heading assignment. An immediate project was to have been the indexing of almost 8000 company reports, so the necessity for knowing indexing techniques was stressed. A few weeks later word came that the opening was closed and, for the time being, no further applications would be accepted. There were also these comments: "Frankly we have been very surprised at the lack of response

to our advertising, personal contacts, et cetera. Apparently there must be a critical shortage of qualified technical librarians... In view of this shortage, we are a bit surprised that more people are not entering the field. In our own case, for example, salary was a secondary consideration."

Comment. In contrast with the previous example, a negligible response was received to advertisements. As in the case of No. II, the employer also used personal contacts and all recommendations were followed up promptly. Although analyzing its reports would give one a rich background in any organization in a minimum amount of time, it is possible that responsibility for a huge backlog of indexing, leaving too little time for administrative and/or reference work, lessened enthusiasm for the position. It is encouraging to know there are openings for general science students. In fact, broad training in the sciences was mentioned in at least five replies rather than emphasis upon chemistry alone, or "overspecialization," as one person expressed it. This is another case in which a high salary failed to attract a suitable applicant. It is somewhat the reverse of another instance, arriving too late to be included in the analysis, wherein the applicant was qualified but would not accept the salary offered. The offer could not be made commensurate with qualifications because the salary schedule of the entire literature group would have been thrown out of line. Is this not significant?

IV. The head of a food company library described his experience with three library school graduates in the same position, reporting that they failed to remain because they lacked a fundamental interest in the subject as well as an appreciation of the services offered by an industrial technical library. "We are of the opinion success in a technical library program requires qualifications comparable to that of any other research worker: high intelligence, adequate scientific background, and a keen interest in research. We have finally put over this point with the Personnel Department, whose members are now willing to do the same screening for placement on the library staff as for any other research personnel appointment. We will no longer compromise and accept a person of less ability or background. To do so requires too much time spent in training," were his words used in describing the situation.

Comment. This position has now been filled, through interdepartmental transfer, by a chemist who had developed a keen interest in literature work and was also pleased with the opportunity for "promotion from within." The solution indicates that the person might not have accepted the transfer had not the salary and status been comparable with laboratory work. It is to be hoped that each will increase proportionately with the incumbent's experience and capabilities, since high morale is just as important to the literature chemist as it is to other human beings. It is also understood that this transfer did not involve a "misfit" in another department — a complaint one often heard when librarians first became vocal over the lack of qualified personnel(7). As for the inability of three unsuccessful individuals to understand the function of company library service, could it be possible that each did not possess the innate capacity to grasp its significance? If true, then an excellent case is made for more careful selection of library school candidates. A similar complaint involving two chemists is reported in the next abstract.

V. On two occasions during the past 3 years a replacement was needed for the library staff of the research and development division of a company concerned with coal and its by-products. Each time college graduates with chemistry majors were employed, one with no library experience and the other with experience limited to clerical duties in a college library. Neither one could adapt himself to the services offered to chemists and chemical engineers, nor did either indicate an interest in further academic preparation, although the company encouraged it. Since the work load did not allow time for in-service training, even had the employees possessed the capacity for it, their resignations were accepted. The employer in this case is sure the position will be filled successfully only by one who is, first of all a librarian, but who also possesses a broad science background with some knowledge of chemistry. For this combination he is willing to pay adequately.

Comment. The foregoing illustration hints of the situation created among a small staff when an inadequately trained person is employed; there are simply not minutes enough in the day for the administrative head to develop and teach the techniques of documentation, the content of reference tools, and the philosophy of literature service. Library science is not learned in six easy lessons! Then, too, there are college graduates who have majored in chemistry yet have not had the slightest experience in using bibliographical tools, not

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even Chemical Abstracts. Though they have written term papers and can handle chemical symbols with ease, these skills are not nearly enough. The contrasting experiences noted in No. IV and No. V are the same ones that caused the old controversy of subject knowledge versus librarianship. Actually, adequate working knowledge of the two subjects is needed when both are to be used. As one librarian recently remarked of this necessity, "It is the safest means of playing both ends against the middle"(10).

VI. An oil and fat products company was fortunate in finding two successful and well-adjusted literature chemists. One offered an M. A. in biochemistry, a reading knowledge of German and French, plus a course in chemical literature. The other, a chemistry major with a bachelor's degree, read German, liked detail work, and had considerable experience in literature work. Of several others employed during the last decade, two left in less than a year because they had been overpersuaded to try this specialized work which they did not like. Three others lacked adequate education; hence they now require an undue amount of on-the-job training, supervision, and assistance. This employer has reached the conclusion that, to be immediately successful, the employee must have had training in literature work, know two or more foreign languages, and possess at least a master's in chemistry. To offer only a bachelor's degree, a candidate should have a knowledge of languages, a natural aptitude for using the literature, and a willingness to pursue further study. In every case he must actually enjoy working with the literature of chemistry.

Comment. Because literature service is required in two plants some distance apart, this administrator had little time for on-the-job training of new employees. He has, however, formulated ideas of what he is looking for and translated his ideas into specific educational qualifications. These he has learned are minimum essentials. As there is little uniformity of concept in relation to education of literature chemists, these ideas constitute a real contribution. A chemist himself, in no way did he decry the importance of laboratory work, but he did emphasize the fact that literature work requires a different type of person -- one who approaches it with the conviction of its importance as a distinct occupation. He has also been willing to admit his unsuccessful attempt in "selling" a career to those who offered skepticism and resistance. On the other hand, there have been instances where a person wholly unfamiliar with literature work may like it, once he realizes he is a creative member of the research function. In fact, the situation next described shows results wherein the "selling" technique paid dividends.

VII. Petroleum technology is the field of a large company which employs more than 30 literature chemists in the library, patent department, and technical files. The employees are satisfied and turnover is no greater than that normally expected of young women. Inasmuch as a description of the three groups and the general requirements for positions in each were submitted, permission has been obtained to include these (Table I). This organization prefers to employ chemistry majors immediately after graduation, as it has been demonstrated to them that skills acquired elsewhere are seldom of much value in their specialized types of work. The annual program of recruiting trips, to be made by enthusiastic persons familiar with the work to be done, has been set up as an addition to the regular company recruiting plan. They have found that it is often necessary "to sell" the jobs to students who have had a great deal of fun in the laboratories during college days but have made little use of the literature. In fact, it has been their experience that too few students know about literature work because faculty counselors, remembering how difficult it was to place women chemists in depression days, still feel that women have no choice but to study nutrition or prepare to teach.

Comment. While many are seeking experienced personnel, it is interesting to find an organization's active avoidance of it. This circumstance is, on the whole, encouraging, as it indicates there are opportunities for the college graduate with no experience. Emphasis on the new college recruitment plan indicates that management is thoroughly sold on the program. To the potential literature chemist it means he is still in a seller's market. To other administrators, who must compete for these same graduates, it indicates that plans to present their positions to candidates should be made early and effectively. An examination of over 50 company recruiting booklets revealed but one illustration of an information center; its purpose was to show the chemist doing library research rather than to depict the literature chemist in his habitat. As for the professors of chemistry, some actually may not be aware of the opportunities in literature service. Others

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may be biased toward preparing teachers and laboratory workers. On the other hand there are some professors of chemical literature who have expressed a wish to do anything short of shanghai-ing in order to get students into their classes. Even if successful, they know that all too few students have serious intentions of making a career of literature work.

VIII. The manager of information services of a research laboratory outlined nine positions available to technical writers, librarians, and literature searchers. With three positions currently vacant, eleven persons have been employed over a period of 4 years to fill these positions. Three of the eleven persons were promoted from within. All of the usual factors of service in the armed forces, marriage, and personality conflicts account for some of the turnover, as well as the more unusual one of promotion to a higher type position within the organization. He reported that one did a passable job, first in writing, and then in literature searching but, because he could not move up the ladder fast enough, he accepted a responsible position elsewhere. Another chemist attempted and failed as head of the library and technical filing service; his lack of documentation background could not be compensated for quickly enough by on-the-job training. A third chemist is, at present, attempting literature and patent abstracting and chemical coding; he is having difficulty with adequate coverage of abstracts. This company often spends $300 to $1000 to fill vacancies which usually are open for several months.

Comment. Although the majority of openings are attractive to those who fill them in the matter of salaries, working conditions, professional type of work, and opportunities for advancement, this particular company manager is convinced that a real shortage exists. He has, as have several others, contributed at least the equivalent of a year's graduate education to several of the literature chemists who have been fitted into their positions. Furthermore, when one realizes there are nine positions available to literature chemists in just one organization, surely one would need to spend only a short time in "guesstimating" two figures -- first the approximate total of literature chemists now employed and second, the potential employment figure in 1975, just 20 years away. The fact that universities anticipate a sharp increase in enrollment presages a greater supply of personnel within 15 years. But this is not as encouraging as it first sounds, unless a more significant number of chemistry majors choose a career in literature work in proportion to the increasing number of positions developing daily.

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Unabstracted Reports

Some of the comments made in the remaining replies may strike a responsive chord. One was that occasionally a chemist might feel the path from the laboratory to the library a downward one in relation to employment. This feeling is less likely to exist in organizations where literature chemists have salary, perquisites, and status comparable to other professional employees. While arrangements might be made for a valuable member of the literature group to spend a stipulated amount of time in the laboratory, there is an excellent reason, from a supervisory standpoint, why such a plan might not be practicable. But, as a respondent commented, "Management expects the employee to be flexible; there may be instances where it is to the former's advantage to put the shoe on the other foot." Other observations from at least five of those replying indicated their experiences with specialists who, though highly competent subjectwise, lacked one or more qualifications which stood in the way of group efficiency or personal success such as ability to follow directions, enthusiastic approach to the clientele, facility in both written and oral expression, and, in spite of an analytic mind, a "nimbleness of wit" necessary to both the indexer and reference worker.

Though there was some similarity in the difficulties mentioned, there was little in the specific remedies suggested. For example, the director of information in an agricultural chemicals company raised the question of creating an M. S. degree in literature chemistry to be offered by a few major universities. Intriguing though this idea is, and it is certainly worth serious thought, it might fall short of achievement until schools of chemistry are established as separate components of universities. Another made the suggestion of developing a booklet on "Careers in

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TABLE I. OPPORTUNITIES FOR WOMEN CHEMISTS

The first step in undertaking research is to locate and review information already available in the particular field. At Shell Development Co. this important step, which is in itself a research investigation, is entrusted to three specialized groups of professional women chemists. As for other scientific research, the primary requirements are a professional degree in chemistry and a professional feeling toward chemistry as a career. Since similar qualifications are required, Shell Development Co. makes no distinction as far as privileges or starting salary is concerned between individuals engaged in literature searching and other professional researchers.

The three specialized groups which handle and review recorded information include:

1. Technical Files, which handles research information confidential to the Shell group of companies.
2. Patent Library, which maintains a collection of patents, journals, and other patent publications.
3. Technical Library, whose collection includes all other forms of published scientific information.

A position in any one of the three groups requires, in addition to technical skill, the personal qualifications usually associated with the successful research worker in a large laboratory. These qualifications may be described as intellectual curiosity, ingenuity, capacity for independent thinking, and ability to work as a member of a team, as well as those virtues so handy in all of modern society, patience, and a sense of humor.

1. Technical Files

The work of chemical abstracter in Technical Files is best understood in terms of the activities of the department. The function of Technical Files is to receive, route, file, classify, abstract, index, and search all technical correspondence and reports received and prepared in the course of research activities of the Shell group of companies. Using their indexes, material in their files is searched to provide data for executives, chemists, engineers, and patent lawyers.

A bachelor's or master's degree in chemistry or chemical engineering is prerequisite and any background in petroleum technology is most useful for a position in the Technical Files group. In addition to these qualifications, it is important to have an analytical type of mind, a liking for organization, and a logical, consistent, and accurate approach to an investigation. A knowledge of foreign languages is not required.

2. Patent Library

The Patent Division of Shell Development Co. carries out all patent activities for the Shell group in the United States and Canada. This requires, in addition to a staff of 21 patent attorneys, an extensive patent library and a group of chemists who specialize

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Chemical Literature." This appears to be grist for a cooperative project within the realm of practicability. It would be an excellent vehicle for classifying various duties of literature chemists, listing their qualifications both personal and educational, and outlining available plans in universities and colleges for the education of students for the types of specialization considered. It might also be the means of clarifying the terminology of titles used in literature work. Although the "title holders" appear to co-exist peacefully, the present situation, largely a matter of either semantics or status, is more likely to confuse than to attract.

Other suggestions were included which seem worthy of consideration. Although the chief of a 20-man literature group has expressed opposition to the idea, the head of another group remarked that he would welcome the opportunity of experimenting with an internship plan which has been developed by one library school for two of its students holding master's degrees in chemistry(3). This same school

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

IN NONLABORATORY RESEARCH POSITIONS

in abstracting, classifying, and searching of patents. The patent attorney outlines to the chemist the field to be searched. The patent searcher must be responsible and independent, because future actions depend on her accurate report of the patent situation at the time of the search. A good reading knowledge of French and German is required.

3. Technical Library

The Technical Library provides basic reference facilities for the company's research efforts. In addition to requirements already mentioned, a reading knowledge of French and German is essential for all library positions; other languages, particularly Russian, also are advantageous.

There are two types of professional positions in the Technical Library. The first of these positions might be considered as library work and includes cataloguing and indexing scientific literature and maintaining the reference and loan facilities of the library. In addition to chemistry and languages, training in library science particularly directed to the scientific field is highly desirable for this type of technical library work.

The second type of professional position in the Technical Library is as a member of a specialized search group. This group, in cooperation with the Patent Department or with the various research and development departments of the company, handles all but the shortest searches in published scientific work. A master's degree in chemistry is desirable for this position. Furthermore, at least one person in the group must be able to read Russian and everyone in the group must have a reading knowledge of French and an excellent reading knowledge of German. Training in library science is not needed; however, it permits more flexibility in library staff assignments.

Job Training and the Future

Professional women chemists who meet the qualifications discussed above receive training in specialized techniques required for their particular positions. Furthermore, as an individual gains experience and becomes more competent, increased professional responsibilities and administrative duties are assigned.

In these specialized fields of literature research, there are opportunities for professional growth and development and advancement. Promotion is from within the company, and opportunities for transfer to similar groups in other branches of the Shell organization occasionally arise. Transfers to laboratory research positions are seldom made, however, as the transfer of a well-trained specialist cannot be accomplished without a definite loss in efficiency.

Salary progression is based on a regular salary merit review. This review is designed to maintain salary levels consistent with the individual's value to the research organization.

The positions described are in a comparatively new field, and one which has been developed largely by women. As such, it offers considerable scope for personal and professional advancement.

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is experimenting with transfer of credit for specialty courses given by another school at the graduate level. An experienced literature analyst wondered if some members of the Division of Chemical Literature would be available for part-time teaching in either chemistry departments or library schools. Another correspondent asked if literature chemists had been included in the Scientific Manpower Survey, while still another suggested exhibits at science fairs and at national meetings of science teachers. Another idea had to do with the Annual Science Talent Search -- namely, that each division member should be a committee of one to suggest to the local high school chemistry teacher that encouragement be given to some student to develop a problem in chemical literature. Even if only one such entry made the finals it would go a long way in establishing this specialty in the minds of both students and professors.

Support. Although three facets of this problem -- Placement, Support, and Per-

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

formance — were integrated with the case situations reported, the importance of the question of support in relation to salary, status, and satisfaction on the job should be re-emphasized. A start in the right direction is currently reported by the head of the technical information bureau of an English firm, who analyzed 149 replies to a questionnaire in order to show the attractive features of information work as a career. He gave results in nine tables: qualifications of science graduates; average and median salaries by age groups, by different types of employment, and for various types of qualifications; classification of graduates as scientists and as librarians; status relative to colleagues in other types of work; use made of scientific training; reason for choice of career; and the extent to which literature specialists are regarded as "scientists in their own right." Although the reliability of the sampling is not known, the author feels that his tables and interpretations indicate definite trends(2). Actually there has been no comprehensive survey of any sort made in this country which reveals facts and comparative data in these categories, just as there has been none for the supply of and demand for literature chemists.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch002

Conclusion

In ending this review of a many-sided problem, emphasis is given to the fact that no immediate solution is at hand. Suggestions for improvement are scattered throughout the paper, with the hope that they may gain unified professional consideration. Many questions have been raised and, while no one is staying for the answers, answers there must be if the situation is to improve "all across the board," or even in part. The replies contain some contradictions, but if one statement were to be selected for reiteration -- one which is in no way contradictory -- it would be that industry is seeking more and better qualified literature chemists. It hopes there will be a response to needs, just as it has been rallying to the support of schools. Although nothing decisive is expected today, discussion can be catalytic, in that those with a problem are meeting with those who can aid in solving it. It is necessary to reach an understanding, so that the very least to expect is that every matriculated science student be given the opportunity to learn about information work to the degree he hears about other fields of chemistry and its specialties. In spite of minor difficulties, there are promising futures for those who are willing to prepare themselves adequately, do some overtime thinking, and orient themselves to the requirements of the job.

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Received September 16, 1955.

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

Literature Searchers as Needed By the Chemical Consultant

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If a laboratory chemist is versed in the use of a technical library, he is more valuable to his employer than without such knowledge. His value increases in proportion to his know-how of where to look for information, and how to look for it. He should be familiar with the use of standard texts, technical encyclopedias, and above all, Chemical Abstracts. Many inquiries received by a consultant may involve only writing a letter for information, looking up material in report or "information" files, or asking someone in the organization who might know the answer offhand. A number of examples illustrate the kinds of questions that have actually been received, and how the inquiries were followed up.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch003

Literature searches as conducted by the chemical consultant are highly varied in nature. They may include a survey of the available methods of synthesis of esters of fatty acids, covering patents and publications, both domestic and foreign. Or they may require the answer to a simple question such as "What is the chemical nature of the product sold under the trade name of Hystrene?" Among the personnel of the chemical consultant at least one person should be qualified to make extensive searches, including the more complex types involving the Index Medicus, the Industrial Arts Index, foreign sources, and foreign patent gazettes.

In a consulting organization such as Foster D. Snell, Inc., it is highly desirable for many chemists and chemical engineers to have some experience in searching the literature. These should have at least a bachelor's degree. There are several reasons for encouraging such searches by the lower echelons, so to speak. The laboratory researcher making a literature search may appreciate the importance of something which the more highly trained literature searcher would overlook. He may integrate the data obtained in the search as he goes along. And, most important, he may have frequent need for further searches concentrated on some subtopic of his major problem. One of the chemists in our synthetic organic group is in the library almost daily, often for only a few minutes, occasionally for an hour or two. He could hardly assign his searches to someone else.

A relatively large consulting organization is broken up into operating groups, like an industrial research laboratory. It differs in that it serves many clients in many firms and that the sole product is the result of chemical and chemical engineering work. It follows that the time of officers and group leaders is pretty much occupied with executive work, with outlining projects for the laboratory, checking up on progress, writing reports, and conferring with clients and prospective clients. When one of these people wants a search made, he has two alternative routes. He may call on the library staff to make it, but he more commonly calls on one of his own technical assistants. The more his assistants are able to do by themselves, the better chance they have to increase their knowledge, and to advance in the organi-

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

zation in terms of responsibility and salary. A group leader rarely does his own searches, except very brief ones. A laboratory project being started will usually carry a fixed maximum appropriation--$500, $5000, perhaps more. This includes time spent in the library. The group leader responsible for the project naturally wants to produce results with maximum efficiency in terms of costs. The lower the time charges of the person assigned to the study of published information relating to the problem, the more there will be left to cover the experimental work and the report writing. But if he selects a person who proves to be poorly qualified, the time may be wasted and the appropriation depleted unnecessarily. It is therefore important that the person sent to the library know how to get the needed information promptly and efficiently.

In consulting work, the chemist needs to be able to go from one type of problem to another, and to get some background on each before the experimental work is planned.

Often general reference books may supply needed information on a subject. A start can be made by running through the card catalog in the company library for titles of books that deal with the subject. Perhaps out of several, only one book will contain pertinent information. For example, one client asked about the method of manufacturing a particular vitamin. Several books on vitamins were on the shelves, but one gave more information than the others on methods of synthesis, with references to original articles and patents on manufacturing methods. The Kirk-Othmer "Encyclopedia of Chemical Technology" also gave a useful bibliography.

In Chemical Abstracts, abstracts on the vitamin itself are indexed under the letter used to designate that vitamin, but derivatives are indexed under the chemical name of the vitamin. For example, vitamin B_1 is listed as such under "vitamin," but the ethyl derivative is listed under "aneurine, ethyl." More about indexing and the difficulties involved appears in Crane's paper. A beautiful job of cross indexing is found in Chemical Abstracts. The searcher should follow up all of these cross references, and on some subjects should add a few of his own topics, particularly where a broad field is being covered. For example, in extensive literature search on the agglomeration of fine particles the following subjects were covered in Chemical Abstracts:

Agglomeration
Aggregation
Binder
Carbon black
Dust
Electronic precipitation
Extrusion
Granulation
Particles
Pellets and pelletizing
Pigments
Powders
Size enlargement
Smoke
Spheronizing
Supersonics
Tableting
Tumbling
Ultrasonics

Because it seems easier to illustrate a point by citing specific examples, I will draw on our experience to show the types of questions or problems a searcher in a consulting organization may encounter. The consulting chemist needs to know not only how to make literature searches, but also how to find the answer to practical industrial questions.

Types of Inquiries

Most of the inquiries come from Europe, and result from the "Listening Post" service which is supplied to clients there.

One European client manufactures insecticides and related materials. He might therefore ask: Who makes mosquito repellents in the U. S.? What do they sell for? Is there some outstanding product? Does the U. S. manufacturer of such and such a product have patent protection in my country, and if so can we get a license? If not

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch003

patented, can we get a know-how license from the U. S. manufacturer, with processing directions, etc.? Although Thomas' Register lists manufacturers of chemicals and chemical products, it is not likely to be very helpful for an inquiry like this. (Incidentally, the consultant early learns to use Thomas' Register.) A good approach is to look up mosquito repellents in Chemical Abstracts, find out who holds patents, and write to the companies owning patents that appear to correspond to successful commercial products. In this way the literature often provides an answer to practical problems.

Foreign clients sometimes use a different term from ours, or give a wrong firm name when making an inquiry. One client asked who was making naphtha sulfonate in the United States. That term is not used here, but rather "petroleum sulfonate." So identified, it was then traced by trade names, as the grades are by-products of petroleum refining not offered under their chemical designation.

Another client asked about methods for making solublized starch with per compounds. U. S. terminology is different. By solubilized starch we mean starch in which the molecule has been broken down by hydrolysis, by treatment with mineral acids or enzymes. Searching Chemical Abstracts for information on "solubilized" starch would therefore be following a wrong lead. What the client really wanted to know about, was what we term "oxidized" starch, starch whose properties have been changed by treatment with oxidizing agents. This general term would therefore be the one to follow up, with a search for subheadings on use of per compounds for the purpose.

Suppose a client is interested in learning more about a product for which he has only a trade name, probably also with a description of what the product is claimed to do. The searcher would first look in lists of trade names, in Thomas' Register, the Chemical Week Buyers' Guide, etc. Strange as it may seem, an article may be mentioned by trade name in Chemical Abstracts, but not found in other sources. One might not think of looking there, because Chemical Abstracts is thought of as so highly technical. If a product is described only by trade name in a trade journal or a medical journal, and the name of the manufacturer is needed, the journal can usually supply the firm's name and address. The address for the journal can usually be found in the list of periodicals abstracted in Chemical Abstracts. Sometimes a manufacturer's name can be obtained from a member of our staff versed in that particular field. For example, a British client asked for a sample of rigid plastic piping made by the Agile Company. When I couldn't find such a company in lists of manufacturers, I asked a member of our engineering department if he had ever heard of it. He said there was a company by a similar name, the American Agile Corp. This proved to be the one sought.

Some clients are very much up to the minute--especially the British--and have asked for a sample of a product being test-marketed. A firm doesn't usually like to give out samples still in the test-market stage, so you need to find out where the test marketing is being done. (This example is mentioned, not because it illustrates a method of getting information from the literature, but because it shows how useful membership in the ACS may be.) I found out through a friend the name of the city being used for the test market--the only place where the new product was on sale in the stores--and looked up the ACS members living in that city, by use of the current ACS directory. Knowing no one there--this happened to be in St. Charles, La.--I picked out a name at random, wrote a letter requesting that a package of the product be sent to me, and promptly received a very nice answer, as well as the desired samples. I have used this method more than once; it has always worked.

These illustrations show some of the types of inquiries a consulting chemist may have to answer. They suggest that the consultant needs to be informed not only on how to make general literature searches, but also on sources and methods of securing practical information.

Received September 16, 1955.

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

The Training of Chemists For Abstracting and Indexing

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Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch004

Abstracting and indexing are important factors in record keeping for science. Both require a comprehensive knowledge of the science and special knowledge of the specific field in which work is done. Chemists preparing for abstracting and indexing should learn languages, including English. The American chemist should cultivate rapid reading with adequate comprehension, and skill in clear, concise expression in good English of the significant information learned by reading. A knowledge of chemical nomenclature is essential. Practice is important as a means of gaining judgment as to what should go into abstracts and what should go into an index. Accuracy and thoroughness are necessary. The growing possibility of mechanized help and its limitations should be recognized.

For effective general growth in science, learning by experiment and by experience must be followed by adequate primary reporting and then by suitable secondary documentation to ensure ready availability for use of the new information obtained. Of the secondary operations, abstracting and indexing are the most important. Just about every branch of science (often smaller units of scientific activity also) needs to keep a practicably usable record of all that is being learned in its field. To accomplish this purpose abstracting and indexing services are increasing in number and extent, and more and more scientists are learning to abstract and to index.

In chemistry a good many learn to abstract, only a limited number to index. Both activities require a good comprehensive knowledge of chemistry and considerable special knowledge of the specific field or fields in which work is done. In this discussion of the training of chemists for abstracting and indexing, adequate chemical education is assumed. From the nature of their work abstractors and indexers have an excellent opportunity to grow rapidly in chemical knowledge as their work progresses.

Both abstracting and indexing are arts as well as sciences. Too often the assumption is made that a sufficient knowledge of the subject matter involved is enough for the preparation of a good abstract or a good index. Considerable training and much experience are necessary, if both operations are to be well done. This is particularly true as to indexing. Much scientific information recorded in journals and books has been lost for effective use because of poor indexing. A storehouse is a hiding place when an adequate key to all portions thereof is not provided.

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

Chemists preparing for abstracting and indexing, particularly for the former, should learn both to read well and to write well.

Abstracting

The cultivation of rapid reading with retentive comprehension makes for productiveness in abstracting.

The cultivation of a clear, concise writing style is essential for good abstracting. This paper cannot provide lessons in the use of the English language, but it can, and does, emphasize the value of learning to use the proper words properly put together. Good abstracts are so worded as exactly to convey information to others and with maximum possible facility. Such abstracts call for good technical writing. For chemistry such writing requires a sufficient knowledge of chemical nomenclature in addition to mastery of grammar and an easy style. In the work of Chemical Abstracts we strive to cut down dangling participles, to avoid split infinitives, and otherwise to observe the rules of careful usage. Even in brief abstracts pride of pen is proper. Above all we avoid a telegraphic style, one which is like notes jotted down, because brevity is not worth sacrifice in clearness. Abstracts can hardly be literary gems, but they can consist of good writing adapted to the special purposes of abstracts. Emphasis is placed here on the use of good English in abstracting work, as this is a primary requirement, and many of us seem to need to grow in this respect. Words, phrases, and sentences are the building blocks of abstracts and of indexes.

Abstracting is good practice in writing.

Because science is international, and original papers, patent specifications, and the like appear in many languages (probably as many as 40), the effective abstracting team must be made up of abstractors who can read the languages encountered. An individual entering an abstracting career is well advised to learn to read at least two or three additional languages with clear understanding. Chemical Abstracts does not think of its abstractors as being translators. For the most part they read the publications being covered and then write the abstracts in their own words. Translating and then abstracting are slow business.

American and British chemists are fortunate in that a little more than half of published chemical papers now appear in the English language. Americans are somewhat unfortunate in that, as a national group, we are poor linguists. All European nationals have close neighbors who speak different languages and this circumstance has led to the learning of several languages by many. Our life apart has led to a degree of provincialism in language learning. This is a handicap in abstracting.

German is again the second language in chemistry. In the early days of Chemical Abstracts over 40% of chemical publication was in the German language. About one fourth of published chemical papers were in German as late as the early 1930's. World War II cut down German chemical publication to a very low point, but considerable recovery is now in evidence. Publication in the German language (in Switzerland and in Austria as well as in Germany) seems now to be in the range of 10% of the total.

Experience in the work of Chemical Abstracts would lead us to list other languages with considerable use in chemical publication in the order French, Italian, Russian, Japanese, Spanish, Dutch, Swedish, Polish, Portuguese, and Czech. Several important Swedish journals and a good many Japanese journals are now published in English. The above order is based on counts of journals of chemical interest appearing in the languages listed. It is fully recognized that this is only an approximate indication, not an exact measure. Publication practices vary in different countries. Some countries publish more journals than others without publishing more papers. Each of a few journals, such as the Journal of the American Chemical Society, the Journal of the Chemical Society, and Helvetica Chimica Acta, publishes more papers in a year than do all of the journals appearing in some of the less widely used languages of science. In 1954, for example, the Journal of the American Chemical

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch004

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

Society published 2472 original papers or briefer communications. When a language is used in several countries, as is Spanish, the significance of journal counts must be discounted.

In learning and practicing abstracting it is wise for the abstractor to provide himself with the best available technical dictionaries and glossaries, whether or not these are in his own language alone or are bilingual or multilingual. UNESCO is now undertaking to help in the improvement of scientific terminology and lexicography with the hope that international, multilingual glossaries or dictionaries will become increasingly available and increasingly useful. A bibliography of interlingual scientific and technical dictionaries, published by UNESCO in 1954 (price $1.75), gives particulars of 1629 such works classified and cross referred under 237 subject headings. A bibliography of technical glossaries containing definitions in single languages is being prepared by Technical Committee 37 (Terminology:Standardization) of the International Organization for Standardization.

After English, the range of differences in the quantities of chemical publication in the first half dozen languages listed is small. Chemical publication in Japan is growing rapidly. Important new chemical information is appearing in other languages, but a complete list is beyond the scope of this paper.

In the Chemical Abstracts work we undertake to teach abstracting by providing detailed, printed instructions and by writing to abstractors concerning editorial alterations or additions which have been necessary while the abstractors have been learning.

CA's "Directions for Abstractors and Section Editors" is a 46-page booklet containing information on assignments, procedures, style, forms, abbreviations, nomenclature, notation, and numerous miscellaneous details, as well as a full discussion of the nature of the abstract desired. This booklet is indexed by subjects. Chemical Abstracts has a special 14-page set of "Instructions for Abstracting Patents," and, for the sake of emphasis, the more important directions for abstracting are frequently distributed as a separate group in so-called "'Abstracted' Directions."

Great emphasis is placed on making abstracts complete from the indexing point of view. This calls for abstracts to include every measurement, observation, method, apparatus, suggestion, and theory that is presented as new and of value in itself and to report all new compounds and all elements, compounds, and other substances for which new data are given.

It is considered (1) that abstracts should be informational rather than descriptive, (2) that as much brevity as is consistent with adequate clear reporting is a virtue, (3) that abstracts should not be critical, (4) that their length should be influenced somewhat by the accessibility of the source, a readily available paper being abstracted more briefly than one difficult to obtain or to read, (5) that new data should be given with adequate precision, (6) that an author's purpose should be made clear and his conclusions reported, (7) that new terms should be defined, and (8) that abstracts should be helpfully correlated by the inclusion of CA references to definitely related earlier abstracts.

The examination of published abstracts is usually helpful to a beginning abstractor.

A full, detailed description of what is regarded as a good abstract would take more space than is available in this paper, but this information is in the "CA Directions," and copies of this booklet are available for distribution at cost price (25 cents). That this booklet is widely used outside the work of Chemical Abstracts is evidenced by the fact that since the last revision (in 1952) 3600 copies have been sold.

Indexing

Indexing is much more difficult to learn than abstracting. Abstractors can often become proficient in their work within a few weeks or at most a few months. Chem-

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch004

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

ical Abstracts considers that it takes at least two years to train one of its subject or formula indexers and that he usually does not reach top proficiency and productiveness under 5 years of active indexing. Much experience is necessary in acquiring the confident judgment needed in building the kind of key to the world's chemical literature which really unlocks every compartment with certainty and with maximum ease.

There are, of course, various kinds of indexes. Chemical Abstracts produces indexes based on (1) authors, (2) subjects, (3) chemical formulas, (4) patent numbers, and (5) organic ring structures. Each of these presents a number of problems; none is as simple as might be expected at first thought. Because of transliteration difficulties presented when different alphabets are encountered, because of a surprising number of like names, and for various other reasons, even an author index calls for considerable study and experience before a good product can be guaranteed. The discussion in the following paragraphs is restricted to subject indexes.

The student of subject indexing should begin by reading a treatise on indexing. There are definite indexing principles to be learned before practice can be good. A good reference is "Indexing" (3). A discussion of the indexing of abstracts (1) is also of interest. Only the more general principles can be briefly outlined here.

Everything else being equal, it is best for subject index entries to be made where it is thought likely that most readers would look first.

The nature and purpose of an index have much influence on the kind of subject index to prepare. Suitable subject headings vary not only with subject matter but also with the degree of comprehensiveness of the field covered. For example, in covering a comprehensive field such as chemistry, the heading "Petroleum" is appropriate and useful, but in covering a treatise on the petroleum industry such a heading would be inappropriate (too general for more than a very few entries). The influence of the purpose can be illustrated as follows. In indexing a compilation containing information on the iron ores of Brazil, the heading "Iron ores" would be the significant subject in an index built for chemists or for geologists, but "Brazil" would gain significance in an index prepared for geographers.

It is important to realize that true subjects and not words should be the basis of subject indexing. The indexer must use words carefully, but he must index subjects. To illustrate the difference between word indexes and true subject indexes let us consider such a series of article titles as follows: "An apparatus for the determination of carbon dioxide," "A new absorption apparatus," "Apparatus for use in the analysis of baking powder," "An improved potash bulb," and "Flue-gas analysis." Word indexes would no doubt contain an entry under the heading "Carbon dioxide" for the first title, under "Absorption apparatus" for the second, under "Baking powder" for the third, under "Potash bulb" for the fourth, and under "Flue gas" for the fifth, and probably no others. These entries seem reasonable enough if the titles are considered separately without thought of the others. And yet the articles may all be descriptive of the same sort of apparatus. As a matter of fact, all of these titles might conceivably be used for the same article; if the author happened to be working on baking powder or flue-gas analysis when he conceived the idea for his novel piece of apparatus or had it in mind particularly for one purpose or the other, he might choose one of the more specific titles for his article rather than one of the more general ones. In an index entirely based on subjects rather than words it would be the task of the indexer to see that all of these articles are indexed under one heading, or all under each of more than one heading, best with cross references pointing from the other possible headings to the one or more headings used. Or if there seems to be some justification for scattering owing to differences in point of view (word indexing cannot be gotten away from entirely), he will make sure that the necessary cross references are supplied to lead the index user about from heading to heading, so that if any of the entries is missed it will be his own fault.

True subject indexing carefully controlled leads to consistency in an index, and consistency is of much importance. Word indexing leads to omissions, scattering,

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch004

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

and unnecessary entries. Scattering is one of the more serious faults of many existing indexes.

For most purposes thoroughness is necessary in good indexing. A given paper or abstract may be adequately indexed with a single subject entry, or a thousand entries may be required. A thousand entries would represent an extreme case. Chemical Abstracts has exceeded this number for a single abstract, but our average is approximately five subject entries per abstract.

An adequate supply of cross references strongly increases the usefulness of an index, or at least facility in its use. Chemical Abstracts maintains a growing master file of approximately 50,000 cross references which are used as needed, which help in the indexing work, and which are applied both in regular form and in inverted form at editing time to guarantee consistency of the indexes.

In deciding on subject entries to be made for an abstract or a paper, many factors need to be taken into consideration. Among these are the author's purpose, his point of view, the new data reported, new or modified methods and apparatus used in obtaining these data, significant relations brought out (as between color and chemical constitution in a chemical study of dyes), theories formulated, new substances prepared, suggested or likely uses for new substances (as in indexing patents), possibilities for the utilization of material (as certain so-called waste material), desirable groupings based on properties, processes, or operations, and effects such as industrial poisoning. Chemists are much interested in compounds and their reactions and other properties. Many compounds have two or more names. One of the real challenges to the chemical indexer is the consistent indexing of compounds so named and arranged as to avoid scattering and to bring a maximum number of related compounds together. A formula index tied to a subject or name index for compounds makes an effective combination. Indexing compounds by groups is under consideration.

The need for a subject heading list is felt by some indexers. In the building of each annual subject index Chemical Abstracts regards the index of the preceding year as a preferred substitute for a subject heading list. In indexing the whole of chemical progress annually we need room for growth and flexibility. Subject heading lists are no doubt helpful under many circumstances. For us use of the preceding index serves more effectively. In addition to information as to established headings and types of headings, the index provides the indexer with information concerning modifying phrases, diction, syntax, and structure. A subject heading list built up by one group of indexers would be useful to others only in case the other indexers wish to cover the same kind of subject matter for the same general purpose.

Except for cross references, an index entry consists of (1) heading, (2) modification (the modifying phrase such as "purification of" under a heading such as "Benzene"), and (3) reference. Selecting the proper headings under which to index an abstract or paper is the most difficult operation for an indexer to learn. This calls for certain general qualifications for the work, which can be acquired only by experience, these in addition to wide acquaintance with the whole branch of knowledge involved and the ability fully to comprehend what the author is reporting. These general qualifications are good taste, good judgment, and a habit of conciseness and of liberal and comprehensive thought. Furthermore, and above all, the indexer needs what may be called the indexing sense. This has been described by Nichols (2) as "the ability to feel instinctively, at the first glance, what and how subjects should be indexed in all their ramifications, the sense that is in touch with searchers and appreciates just how subjects will be looked for and how to arrange so that they can most readily be found." The effective selection of headings under which to make entries calls for ability to think in terms of true subjects rather than words and then for learning the key words to use. These words may or may not be in the material indexed.

Good modification writing can help considerably in the use of an index. For an

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch004

extensive index it is well for modification writing to be more or less systematic with an alphabetic arrangement of entries.

While accuracy is, of course, important in all indexing steps, great care is needed to keep references accurate.

In the work of Chemical Abstracts, for which subject indexing is done by dictation over wire recorders, beginners are asked first to check a large number of transcribed index cards made by an experienced indexer. This operation serves to pick up transcribing errors while a student is learning what has been done. After a certain amount of experience has been gained from checking index cards, the situation is reversed. The indexer is asked to tackle the indexing of some abstracts and the experienced indexer does the checking; this is followed by the pointing out of mistakes of omission or commission. The index student is then given what we call first-survey editing of assembled index cards and his mistakes are pointed out by the experienced second-survey editor. The student may next help in reading some index proof, with an experienced proof reader following him. These operations are continued for at least two years before the indexer is put on his own. Even after that a good deal of checking is done. For a while at this stage an experienced indexer designates headings and the learner writes modifications of his own. Weak spots in the indexing of Chemical Abstracts are considered intolerable. We go in for thorough training as well as for thorough indexing. In the production of Chemical Abstracts great emphasis is placed on indexing because information would be buried in this huge publication if a truly effective key were not provided.

When helping in the documentation of new scientific information, both the abstractor and the indexer have a fine opportunity for growth. They grow in ability to use abstracts and indexes effectively while growing in abstracting and indexing skills, and they cannot help also but gain stature as well-informed scientists. The kind of wide-awake reading, understanding, digesting, and writing down of new information required for good abstracting and indexing accelerates everyday learning. Every scientist should do some scientific reading; abstracting makes this more effective and it defeats the temptation to neglect this means of growth. Being in abstracting and indexing work is in some ways like keeping right on going to college. The whole world of reported chemical progress flows through the hands of CA editors and indexers. We sometimes think that we could properly add a CA degree to the B.A., M.A., and Ph.D. degrees of many of our CA workers.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch004

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Received September 16, 1955.

Role of the Library School in the Training of Literature Chemists

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Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch005

There is probably no wider divergence of opinion on training for a profession than for that of literature chemist. The current trend seems to indicate that the ideal professional education for literature chemists, especially when the field is broadly interpreted, should provide broad training in chemistry, a good general education, knowledge and skill in basic library methods, and knowledge of the specialized services required of literature chemists. It is in the provision of the latter two elements that the library school has a role in the training of literature chemists. The advantages and possibilities offered by a career that combines chemistry and librarianship should be publicized to college undergraduates. Scholarships and fellowships for potential literature chemists might well be made available by large industrial institutions.

Literature chemists are those who, by virtue of their interests, education, and experience, have chosen to work with the literature of chemistry and its cognate fields. Chemical librarians, literature searchers, translators, report editors, abstracters, indexers, bibliographers, and documentalists are among those who may be included in this category (2).

The problem of the education and training of the literature chemist, then, might well be approached in terms of what such an individual needs to know how to do. Such an analysis discloses the need for the development of certain competencies that are essential to the work. Among other requirements would be the ability to understand and interpret the literature of chemistry and allied fields, to apply general library knowledge and techniques, to locate information, to analyze and synthesize reports of research (both foreign and domestic), and to write a report of findings.

This great variation in the kind of tasks performed, together with a wide range of subject area, calls for training that varies greatly in content, purpose, and techniques. Nor can sight be lost of the fact that the literature chemist exists as an integral part of a highly specialized kind of organization -- an industrial corporation, a research institution, a governmental agency, or the like. This implies the need for a certain amount of in-service orientation in a specific position following employment of an individual with professional training.

Elements of Professional Training

Let us try to identify the elements of professional training. The current trend seems to indicate that the ideal professional education for literature chemists,

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

especially when the field is broadly interpreted, should provide first and foremost a broad knowledge of chemistry which has been obtained against the background of a good general education. This general education should provide an orientation in the other physical sciences, biological sciences, humanities, and social sciences. Today all areas of knowledge are interdependent, despite somewhat artificial subject boundaries. This broad preparation should include a working knowledge of as many foreign languages as possible--certainly French and German, and Russian if at all possible. Included also in the educational background should be facility in oral communication, and training in the writing of clear, concise, and convincing reports, papers, and memoranda.

In addition to this knowledge, all literature chemists must know how to keep abreast of developments in the field, and to locate needed information with a minimum expenditure of time and energy. This means familiarity with the sources of information, being able to make them accessible, and knowing how to use them with the greatest effectiveness. Many literature chemists must know the sources well enough to build a collection that will meet the company's needs, and must be able to organize and administer this collection so that maximum benefit is derived from it.

It is in the provision of such knowledge that the library school has a role in the training of literature chemists. A basic question might well be whether specialized library school education, or even any library school course at all, is essential for the literature chemist. Any hesitancy regarding the need for training in librarianship is understandable. The answer seems to be the same in this field as in others. Many successful literature searchers and librarians have become competent practitioners without courses in the literature of their field and in many cases without any library school courses. The subject specialist with some native ability and sufficient on-the-job training can become a good literature chemist. But subject education today tends to familiarize the subject specialist with a somewhat narrow collection of printed material, and gives little training in the basic principles of reference and documentation which apply to its selection, organization, and use. The actual work of the literature chemist may be quite different from the work done in servicing a collection of chemistry books in a large public or university library, but the materials are the same, or very similar, and so are the basic principles of search, compilation, and documentation. Literature searchers without some training in library science are therefore somewhat handicapped unless their field of operation is very narrow. Certainly the time needed to become proficient is greater for individuals who enter the profession without some library training.

A division of opinion exists as to the feasibility and adequacy of in-service training as a substitute for formal training. Many who have studied the problem agree that training for librarianship is best handled by library schools which will train candidates in the basic library courses and emphasize the philosophical and administrative aspects of the work. Although this training can seldom be pinpointed to a specific library situation, the training should provide a thorough grounding in the fundamental resources of printed communication.

Current Pattern of Education

The current pattern of education for librarianship consists of five or more years of appropriate undergraduate and graduate study. As Willard Mishoff, a specialist in the U. S. Office of Education, indicates (1):

> As an undergraduate, the prospective librarian is expected to acquire a broad foundation including (a) an orientation in the natural and social sciences and humanities, (b) an understanding of government and democracy, (c) a comprehension of the actions and motives of individuals and groups served by libraries, (d) a general knowledge of the literature of various subject areas, (e) a facility in oral and written communication and in reading, (f) a reading knowledge of one or more modern foreign languages, and (g) con-

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centration in at least one subject as preparation for service in a special subject library or for advanced study.

Undergraduate programs in library science are designed to prepare students for positions which require a knowledge of library routines and techniques. They provide knowledge and skill in library methods, not alone to prelibrary students but also to undergraduates who may profit by such instruction.

Library training courses with credit toward a bachelor's degree are now offered by over 400 institutions of higher education in the United States. Common to all of these nonprofessional programs are fundamental courses in bibliography and reference work, cataloging and classification, book selection, and library operations useful alike in school, college, university, public, and special libraries.

These basic courses, at least, might well be part of the educational training of the literature chemist. The value of such training is largely in the methods and procedures which are learned, and the resulting acquaintance with the organization of libraries and the ways of extracting information from them. Such training should result in a useful understanding of the over-all pattern of bibliographic organization and of the library's role in it.

In addition to the undergraduate courses, instruction in the graduate library schools aims to prepare librarians for positions involving professional leadership and administrative capacity. Instruction is provided in the general areas of library materials, organization, and administration with opportunities for specialized study of various types of services and of subjects related to individual interests.

Programs are based on the concept that there is a certain hard core of knowledge basic to all types of library service. Above and beyond this core, most library schools permit students to elect courses in the area of specialized interests. Flexible programs are adapted to individual student needs, worked out through counselling, and commonly include electives in subjects other than library science, such as advanced work in subject specialization. Under the traditional program of library education, a full academic year of graduate study leads to the degree of master of science.

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Training in Literature of Science

A hurried check of the catalogs of some 30 accredited library schools indicates that well over 50% of them offer some kind of training in the literature of science. A number of schools offer more than one course. The University of Illinois, for instance, offers two courses in the general field of science and three in special bibliography. Other courses in subject bibliography and a course in documentation are being planned.

A course called the "Literature of Science and Technology" provides an introduction to the scope and significant characteristics of the literature of science, modern concepts, and representative literary works in each of the major fields.

Representative reference sources are studied in a course called the "Bibliography of Science and Technology." The purpose of this course is to help the student develop a feeling for science reference sources--to become familiar with the types of bibliographical tools and what to expect of each. Such a course cannot be detailed enough nor presuppose the subject knowledge necessary to give the prospective library specialist the optimum experience and knowledge of extensive subject materials and their use. Here the presentation is designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. The great wealth of literature in the scientific fields necessitates certain limitations on what can be covered during a semester course (approximately 48 class hours). However, as in most of the library courses, individual projects give a student an opportunity to pursue in greater detail specific subjects on his own.

To provide opportunity for more extensive study of the bibliographical aids and

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

reference work in specific subject fields, courses are given in "Biological Literature and Reference Work" (1/4 unit) and "Medical Literature and Reference Work" (1 unit), in addition to the graduate course "Chemistry 492, Chemical Literature and Reference Work," so ably taught by Virginia Bartow of the Chemistry Department (1/4 unit).

Two closely allied courses which provide valuable training for potential science librarians are "Government Documents," a 1—unit course in which the student studies the nature, scope, and organization of government documents, and a special course on "Maps and Cartobibliographical Aids " (1/4 unit).

The period of time involved and the variations in backgrounds and specialized interests of students necessitate certain limitations on what is covered in a library school program. This means that library schools cannot always provide a potential employee who is tailor-made to a specific position. For instance, prospective employers occasionally ask why Illinois does not teach a course on research reports (writing, editing, reproduction, acquisition, handling, servicing, etc). Actually, not more than one or two students annually would take such a course were it offered, but by integrating this topic into courses now offered (literature of science and technology, bibliography of science and technology, government documents, cataloging and classification), at least an introduction to this form of literature is provided.

Special Training

Library schools are faced with somewhat of a dilemma! Library education must include a certain amount of factual information, but it must also include ideas and principles which are more likely to be retained. The objective of library school instruction is not so much to prepare the student to fit immediately into his first job as it is to enable him better to adapt to new situations and new problems as they arise in the future.

As it now stands, the contribution of library schools to the educational training of literature chemists will depend to a great extent on the requirements of the individual person. The enthusiasm of most literature chemists, and their employers, for better professional training augurs well for the future. However, unless there is a fairly general acceptance of the responsibility for the training of such an individual by the general college, the library school, and the employer, educational training for the career can be little more than the acquisition of limited techniques.

Most potential employers are keenly aware of the difficulty of finding personnel properly trained to carry out activities that may characterize this kind of position. On the other hand, library educators are sympathetic to the needs of special libraries but are not always aware of the specific demands made on highly specialized personnel.

Once these requirements are spelled out, the actual training of literature chemists should normally begin early in their college careers. Recruits from the ranks of chemistry majors should be encouraged to take courses which provide the necessary techniques in addition to subject training. The advantages and possibilities offered by a career that combines chemistry and librarianship should be publicized to the undergraduate. Some of the library schools will gladly tailor their curricula to include knowledge and techniques which provide for the specialized services required of the literature chemist, if they are assured of interest on the part of more than one or two students.

In fact, the special librarians have proposed a plan which would relieve inadequacies in the library school training for special librarianship. Through this plan certain library schools would concentrate on developing certain specialized courses, thus avoiding duplication of effort and encouraging the registration of a reasonable number of students in each course.

Frequently both the college and the employer lose sight of the fact that there

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

is a limit to the number of courses that a student can take during a normal 4-year program. Unless the student has a specific position in mind following graduation, or the finances to permit additional study, he is going to select courses that provide the "shotgun" approach to various possibilities for employment.

Scholarships

This fact leads to the suggestion that large industrial institutions which have need for literature chemists provide scholarships at recognized universities, which would materially assist students who are interested in training for this career. This is done in other fields of chemistry. Why not make scholarships and fellowships available for potential literature chemists?

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Received September 16, 1955.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch005

College and University Training of Literature Chemists

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Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch006

Not every chemist needs to be a chemical librarian, but every chemist needs appreciation of the literature and its potentialities. The colleges and universities should make students library-minded by providing good libraries, giving instruction and requiring practice in their use, and encouraging recreational reading. Present libraries are adequate, though not always departmentally located as the chemist wishes. Instruction in use of the general library is fairly common, but courses in chemical literature, though more effective than informal presentations, reach only one fifth of all bachelor's-degree chemistry graduates. The schools make literature chemists competent in chemistry itself. However, unless literature searching as a profession is clearly presented, students trained in chemistry may enter more publicized branches.

Every chemist needs to be a literature chemist to some extent. There is probably no argument about this until the extent is defined. Even if the laboratory chemist is to be helped by a technical librarian or professional literature chemist and maybe by a technical report writer and editor too, he needs to know what kinds of information the library can supply, and how long it takes to get various kinds of information. Nobody is likely to appreciate the kind and amount of work involved in preparing a bibliography on, say, chlorophyll, until he has put together some bibliographies himself.

But how many chemists will have the help of a bibliographer or other literature searcher? This question cannot be answered safely without an extensive survey; moreover, the picture is changing. More and more, laboratory men in large research organizations can have their library work done by the literature chemist, though few places yet require them to take this route; they can still work it out themselves if they want to. But the ratio is supposed to be 15 to 25 bench chemists to one book chemist; and in many small laboratories, including practically all academic ones, no literature-searching services at all are provided. Altogether, the majority of chemists are probably still in positions where they must do most if not all of their own searching. If this is not true--if we are nearing the time when the laboratory chemist leaves library work to the library chemist or the chemical librarian--we ought to abandon the requirements of French and German reading for advanced degrees. After all, these are supposed to be, not cultural subjects or mere intellectual hurdles, but tools needed for carrying out research in the library. According to Chemical and Engineering News (4), a panel of industrial research directors said it is unnecessary for colleges to insist on foreign language instruction along with science courses; and there is undoubtedly a lot of head-in-sand attitude about the

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

usefulness of the average Ph. D.'s knowledge of scientific French and German. Still, the AMERICAN CHEMICAL SOCIETY and the graduate schools remain on record in favor of the languages, and so they expect chemists to use the library.

Three kinds of positions may be distinguished: that of the chemist, who knows enough about chemical literature to help himself in the library, just as he knows enough mathematics to get along; that of the literature chemist, who is still fundamentally a chemist but is qualified and inclined to spend much of his time in helping other chemists with library problems; and that of the technical librarian, who is first of all a librarian, specially trained both in a science and in the management of book collections for the benefit of research scientists.

But somewhere in this classification there comes a place at which the literature chemist should become rather the literature scientist. No industrial organization big enough to have a sizable technical library will have its literature limited to chemical topics. Rather, engineering, physics, geology, biology--yes, and certainly economics--may all present areas for investigation and report. Perhaps this necessary breadth need not and should not be emphasized too far in selling the profession to students, for fear of scaring them out; but they will grow into it.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch006

Task of Colleges and Universities

Now what are the colleges and universities doing about the problem? And what should they be doing?

First of all, they should be making all students--both undergraduate and graduate, but especially undergraduate--library-minded. This means first, providing a library adequate for the program of instruction; second, providing some teaching in the use of the library; third, requiring use of the library in conjunction with class work; and fourth, encouraging recreational reading.

On the whole, they are providing the libraries very well, both buildings and books. Discussion about the advantages of departmental libraries versus centralized collections continues to be lively, especially at a school where a change is being considered. Usually the chemists are not on the same side as the college or university librarian. The librarian sees great advantages and savings in having the library all in one building; the chemist is almost invariably positive that he and his students use the literature more and better when there is a good departmental library in the chemistry building. The status and opinion of chemistry departments accredited by the AMERICAN CHEMICAL SOCIETY were surveyed on this matter by Broberg and Dunbar (2,6) in 1951. They found that 80% of the colleges have departmental libraries and 72% have them housed in the chemistry building. The departmental library receives about 40 journals on the average, and shelves about 3000 bound journals and 1000 reference books--but the range of holdings is wide.

Training in Library Use

The college or university chemistry teacher is also ready to vote for having all his students know how to use the library; but there is no agreement on the best way to attain this knowledge. About 400 institutions require an orientation course in the use of the library for some or all students. In fact, this is a common course in high schools, too, and there is a considerable literature on it. One has only to look under the entry, "Libraries, instruction and use," in the Education Index to find some hundreds of entries. Such instruction is apparently almost entirely an American development; European students learn to use their libraries by the sink-or-swim method. The usual library orientation course is of very general nature and not at all specialized toward chemistry or even science, but it may be supposed to make students library-conscious. Indeed, it made them too much so--critically so--at Maryland, where Wedemeyer (13) conducted a survey, reported in College and Re-

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

search Libraries, of student attitudes toward the required library course. She concluded that the assignments did take too much time, just as the complaints said; but only a few students already knew the material presented. Some of this material was also presented in other courses, but not undesirably so. In the end, most students considered the course content useful.

But is it really necessary to have a special course in library methods? Cannot the individual teacher discuss the literature of proper level for each course and let the student find it with a little help from the librarian? Isn't this the best method for teaching the literature of chemistry--to have each teacher explain the sources of information and methods of searching in his field?

This is probably the best method logically, but it just does not work. The average professor in an undergraduate course almost never thinks of presenting bibliographic methods in his branch of chemistry--and if he did think of it, where would he find the time? Of all the 800 pages of textbook, a few may give selected extra readings, but very likely there is not one devoted to naming general reference works, or giving methods of searching the literature. All the teachers' conferences are on what to leave out, not what new to put in. The professor has to be very library-minded indeed if he can wedge much chemical literature into the undergraduate course.

There also have been experiments with occasional guest lectures on the subject in regular courses, or a few lectures in a special course such as a seminar. These are all right as far as they go, but they cannot come near giving students the potentialities and limitations of sources.

This dogma is not universally accepted, inasmuch as chemical literature courses are not universally taught and required. Voight (12) has made a strong plea for the teaching of documentation along with junior and senior engineering courses, especially seminars. Certainly there are very few courses in engineering literature, though Columbia has one (3).

Courses Offered in Chemical Literature

Whole courses in the literature of chemistry are much more common. The history of such offerings is not very familiar, but the University of Illinois has had such a course since 1913; Purdue since before 1928; Michigan since at least the 1930's; and Stanford since at least 1929.

In May 1953, Jahoda (7) published the results of a very pertinent survey on university instruction in chemical literature. This study was limited to the 75 schools listed as granting the Ph. D. in chemistry in 1948-49, of which 60 replied. Thirty-two offered a one-semester course in chemical literature, and 20 required it. The courses were for one or two credit hours. According to Jahoda, the course is best taught at junior or first-year graduate level, but tends to be disregarded and sometimes to disappear unless required.

A little study of offerings in a different way has now been made, by searching college catalogs to see how many list a course in chemical literature; of course, this proves nothing about frequency of offering. Only four-year colleges and universities offering work through physical chemistry were considered, and those granting the Ph. D. were ruled out as already covered. As a sample, only schools with names beginning with A or B were tallied; and of a total of 42, only 6 offered courses in chemical literature. It is not surprising that the ability of departments to offer such a course depends partly on size of staff and diversity of program, but the result is a little disappointing. It is thus possible to guess that not more than one fourth of the students receiving the bachelor's degree in chemistry have had a formal course in chemical literature.

This is about the same as Alexander, Corbin, and Egloff (1) reported in 1944;

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch006

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

they found about 25 courses in chemical literature described in 100 college catalogs. They reported that there was a trend toward increasing the number of such course offerings; but Jahoda found that several departments had let them lapse for lack of interest, so one cannot think the idea of the course is very thoroughly sold to chemistry faculties. We ought to be careful to avoid wishful thinking here, and supposing that, because we believe there ought to be more and better training in the use of chemical literature, there is a trend in that direction.

The courses themselves have been described from time to time at meetings of the Division of Chemical Education. Van Patten (11) reported in 1949 for Stanford, and Richter (9) in 1950 for the Rice Institute. Richter's course was a combination of chemical literature and readings in scientific German; but the German reading wore out the old irreplaceable Liebig's Annalen! Two courses familiar because of the textbooks that have grown out of them are Mellon's at Purdue, and Soule's at Michigan. Ten years ago Gordon had plans for a four-course sequence for training in chemical literature at Wayne University--the usual first course, one on patent literature, and two for experience in abstract and monograph work--each for three credit hours. More than that, the first two of these were to be required of all Ph. D. candidates in chemistry. However, only the first two courses of this ambitious and specialized program were ever put into effect--and Wayne remains one of the very few schools that offer more than one course in chemical literature. Mellon's course has had, as an outgrowth, a sequel course in chemical writing (8).

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch006

The Library Habit

But in requiring use of the library in regular class assignments, it is likely that the natural scientists are far behind the teachers of social studies and the humanities. Maybe because there is no laboratory, or because these fields do not lend themselves to definitive textbook writing as well as chemistry, it has long been standard practice to require considerable library work of even the freshman in English or history--but not in chemistry, or zoology, or mathematics. Chemistry teachers in smaller colleges, where the library and the class are small, probably teach more by way of references than those in the universities, where the lecturer-and-graduate assistant system prevails. To repeat the accusation: Whatever the reasons may be, undergraduate students are not in general forced to acquire the library habit in chemistry--and this is not good for the development of literature chemists.

Besides making students library-conscious and library-competent, schools wanting to train literature chemists should make them competent in subject matter. This is plain enough; the literature chemist will not be respected or trusted by his laboratory associates unless he or she has a good working knowledge of the fundamental branches of chemistry. The prescriptions of the AMERICAN CHEMICAL SOCIETY's Committee on Professional Training, including year courses in general, analytical, organic, and physical chemistry, are well known and widely followed. Even though a library career is planned, the laboratory part of the regular curriculum is important to make the ideas real. Beginning physics, mathematics through calculus, and preferably some biological science are also desirable and always provided. It is not so easy to plan some training in engineering and industrial technology, as suitable courses may have prerequisites so high that they are out of reach. Whatever may be the merits of requiring French, or German, or both for the ordinary chemist (and even for the technical librarian there are some doubts) there is no doubt at all that a real reading knowledge--not just slipping over a hurdle or deciphering with a dictionary, but an ability rapidly to convert foreign scientific articles into good technical English--is essential to the literature chemist. Typing and shorthand are highly desirable, but these skills should have been acquired in high school.

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

Courses in French and German designed specifically to give a reading knowledge are much more common than they used to be, probably because of the expansion of graduate work in science. These courses are not always welcomed by foreign-language teachers, any more than the chemistry teacher welcomes a request to slant and mangle his beautiful subject for some semiignorant special professional group, and they are usually available only at centers of graduate study. Still they represent a gain in the program of training literature chemists, even though at the sacrifice of some general-education values.

For general education we usually think of courses outside the immediate professional concern of the physical scientist: history, English, social studies, humanities, and so on. Probably we should put English with the professional courses for the literature chemist, as Crane has pointed out. Certainly some representation of these liberal-arts fields must be included if we are to have people as broadly trained as we need.

Doubtless we should stop to note an assumption--that it is easier to teach library techniques to a chemist than to teach chemistry to a librarian. This is generally agreed, not because chemists are brighter than librarians, but because of the depth of the subject matter in time; chemistry more than library science depends on a fixed sequence of courses. Ideally the two should go along together. The chemistry student aiming at literature work is greatly benefited by becoming a student assistant in the library, where procedures and attitudes can be picked up by an apprentice.

A serious trouble with the scheme of training the chemist first is that he or she is thereby exposed to the rigors of recruitment for industrial bench work, or teaching, or graduate school, and may be unable to withstand the temptation. In practice, it often happens that science librarians are librarians who have had mostly on-the-job training in science.

As a matter of fact, in recruitment of literature chemists the same problem is encountered that is confronting all physical science today. The statistics presented by the Washington office of the AMERICAN CHEMICAL SOCIETY, and most recently by Smith and Marshall (10), show not only that there is a decrease in production of bachelor's-degree chemists, but that from 1947 to 1950 the percentage of students in freshman chemistry who ultimately graduated with a major in chemistry dropped from 4.5 to 2.2%. College teachers may say that science interest is made or lost in high school, but these figures suggest there is something wrong with our own selling of the profession of chemistry. But, furthermore, we cannot recruit literature chemists if we do not make the opportunities in the field known, particularly to women interested in chemistry. There was a pointed statement published by a technical librarian (5) in 1952, that neither the AMERICAN CHEMICAL SOCIETY nor the Special Libraries Association is doing a good job of interesting students in this field. Unquestionably salary levels have something to do with the problem, although at least some companies pay beginning literature chemists as well as they do bench chemists.

Oklahoma Course in Chemical Literature

The why of teaching a chemical literature course needs no further repeating. The course at Oklahoma A. & M. is designed to give all students in it a working knowledge of the main sources and search methods in chemistry, and perhaps to inspire one person per year to become a literature chemist; at least it has had that effect.

Who is taught? The course is required of all chemistry majors in their junior or senior years, and of all graduate students who have not had such a course. The class of 40 is made up about half and half of these groups. This year it has been scheduled on Saturday morning to permit industrial chemists from nearby towns to drive in for it and then work out the library assignments while there, if they wish.

Who is to do the teaching? Here, as in three out of four schools, a chemist

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Table I. Outline of Library Assignments

1. Chemical Abstracts. Author indexes; subject indexes; "List of Periodicals Abstracted"; preparation of an abstract.
2. Other abstract and index journals. Subject indexes in British Abstracts and Chemisches Zentralblatt; subject indexes in physical science and engineering; subject indexes in biology, agriculture, and medicine.
3. Primary chemical journals. Library holdings of named journal; scanning of current numbers; locating reviews of named book.
4. Organic chemical literature. Information on named compound; formula indexes; information on named reaction; laboratory procedure; locating a review of a class of compounds.
5. Inorganic chemical literature. Named compounds; named minerals; laboratory procedure; review of theory.
6. Analytical chemical literature. Qualitative detection; quantitative determination; specific determination of A in B; official methods.
7. Physical chemistry literature. Information on topic via general works; laboratory procedure; information on topic via monographs.
8. Sources of numerical data. Handbook data; International Critical Tables, Landolt-Bornstein, and Tables Annuelles; solubility via Seidell; other compilations.
9. Industrial chemical literature. Sources of supply for a commodity; price; trade-name equivalent; geographic location of manufacturers.
10. Biochemical literature. Data on a drug; composition of a foodstuff; review via annual reviews.
11. Compilation of a bibliography. Choice of a topic; conduct of search; report.
12. Government documents (except patents). General indexes; production statistics; import-export statistics; Office of Publication Board reports.
13. Patents. C. A. indexes; U. S. document indexes; analysis of an actual patent.
14. Miscellaneous searches. Dictionary card catalog; bibliography on given topic; chemical biography; review of chemical technology.
15. A review paper based on the bibliography prepared.

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rather than a librarian teaches the course. No doubt the question is usually settled on the basis of availability and interest; but the chemical viewpoint and the interest and respect of the class are best guaranteed by having a chemistry teacher in charge.

The course is taught in the new central library. Because it is new, the library has absorbed all branch and departmental libraries; but air conditioning goes a long way in compensating for having to leave the chemistry building. The library is open 106 hours a week, and all shelves are directly accessible to everybody. The literature for physical science and engineering is all in one area, adjoining that for biological science. The library is in the 300,000-volume class and is a U.S. document depository. In chemistry there are all the standard works and current journals, but not many sets of the 19th century German journals. The open-stack principle encourages people to use the library and learn its resources, but it probably discourages use of the card catalog to some extent, and the librarians are not asked for as much help as they could give. People who learn this system will find the closed stacks of older libraries annoying.

The method of teaching is not unusual. There are two hours of class a week, devoted mostly to lecture because of the lack of current textbooks, but partly to trouble-shooting on the library assignments. The lectures are heavily supplemented with exhibits of the materials being discussed, although the layout of the library makes it necessary to bring the materials to the class instead of the class--of 40--to the shelves, as would be better. There are two or three-hour examinations and a final examination. No doubt all will agree that the best examination in how to use the library would consist of actual problems in such use, just as the best way to see

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

whether a student knows laboratory technique is to set him to prepare hydrogen chloride or butyl acetate at a laboratory desk. But the difficulties in assigning and measuring performance in each case are tremendous, and paper-and-pencil tests are almost invariably used, with the hope that they correlate well with the actual ability to do things.

Library Assignments

The library assignments are a major feature of the course, and probably the one that makes students complain about its heavy time demand. A description of these assignments, which also represent the nature and order of lecture topics, is given in Table I. These problems are obviously an outgrowth of Mellon's course and textbook, although they have come to differ from the Purdue units. They can best be explained by quoting the preface of the manual of problems.

> This book provides a set of exercises designed to cover the various sources and types of searches important in chemical literature. The library, like the laboratory, is a place to get information; this book thus corresponds to a laboratory manual.
>
> Obviously the experiences you have in working out these assignments are more important than the information you seek, but for the sake of training in preparation of reports, the chemical data found will often be called for.
>
> In connection with each exercise you should familiarize yourself with the literature of the area. To fail to do so will cost you time and quality of work. Study the textbook and lecture notes dealing with that portion of the library in which the assignment is made, and if possible browse a bit in the library itself, before undertaking the assignment. Sometimes it is a useful device to look up something for which you already know the answer, merely to check your technique--i.e., "run a known".
>
> On questions of general library materials and policy the library attendants are ready to help you, but they are not especially trained in chemistry and often cannot be of much assistance. If on your own initiative you cannot find the required information after a fair trial (one to three hours, depending on the magnitude of search possible), you certainly should appeal to the instructor.
>
> Searches will be limited to materials available in the Oklahoma A. and M. College library: no use of literature from other libraries is required or expected. If it happens that you cannot complete an assignment without such material, simply state that fact to justify an incomplete report; but be sure the material is unavailable and indispensable.
>
> It is a good habit to keep a record of sources consulted in any library search; this is particularly useful if you meet trouble and ask for help. However, such a report is chiefly for your own use and need not be handed in. Reference is to be made to it in reports only when the assigned information cannot be found; then you should list the sources searched in vain.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch006

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Received September 16, 1955.

On-the-Job Training of Literature Chemists in Industry

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Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch007

The chemical industry requires more and more literature chemists to staff its broad-scope information-service programs. At no time in recent years, however, has it been able to employ an adequate number of chemists skilled in source knowledge, abstracting, indexing, coding, writing, editing, publishing, graphic arts, and other branches of documentation. Accordingly, the industry has been forced to take suitable chemists and to give them on-the-job training. Often, this training has been of the "sink-or-swim" variety, especially in small organizations, but some companies combine general company indoctrination, movement through a variety of training assignments, and the use of instruction manuals, books, selected journal articles, and courses in nearby universities.

The chemical industry, in reaching its present state of development, has come to recognize the literature chemist as an important member of its technical team. At the same time, this industry has had to face the fact that there is a definite shortage of qualified literature chemists. Although some universities are now taking positive action to help remedy the situation, a solution will not be effected overnight. Accordingly, companies that urgently require qualified literature workers have had to take it upon themselves to develop their own experts — to select well-qualified chemists and then to give them adequate on-the-job training as literature specialists.

In arriving at this conclusion, industry has also taken another step in its thinking. It now recognizes that the literature chemist is in every sense of the word a professional chemist, just as is the analytical chemist, the physical chemist, and the organic chemist. With this recognition has come the realization that the fledgling literature chemist requires the same in-company indoctrination as other newly employed chemists, if his work is to be most effective.

General Indoctrination Programs

Company indoctrination programs vary widely. They often include a series of indoctrination lectures, in which employees gain knowledge of the purpose and operations of the various divisions of an organization. In some companies, new chemists (including literature chemists) are rotated through a series of assignments designed to give them more intimate knowledge of the work of these divisions before they report for work in a special field, such as literature chemistry. Seminars are often

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

conducted on subjects of importance to the chemist, both as a professional chemist and as one who must learn to develop his abilities in cooperation with others. Courses in public speaking, technical writing, and supervision are not uncommon. Frequently, financial assistance is given to employees who are willing to devote their own time to taking advanced courses at nearby universities. Some companies assign new chemists to a staff member who looks after their development and counsels with them and their supervisors during their initial period of work.

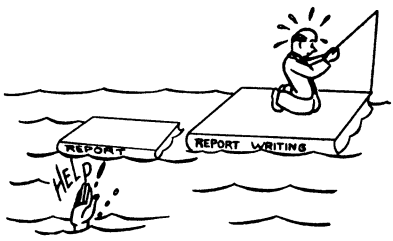
Many companies find that periodic employee-development conferences between employee and supervisor play a significant role. Through these conferences, the individual employee has an opportunity to learn of his own progress and potentialities, as measured by his superiors. Similarly, such conferences enable the supervisors to evaluate not only the performance of the employee, but also the adequacy of the training program.

Incidentally, results of a recent questionnaire sent to some 45 companies thought to be employing literature chemists revealed that approximately half of the 31 companies reporting have formalized training programs for new professional employees. Of these, only two companies indicated that literature chemists are not included. More than three fourths of the companies reporting use employee-development conferences as part of their training programs. However, only seven companies answered the specific question as to how their programs were administered; five of these reported that their training programs are centrally administered, while two indicated that theirs are centrally planned but conducted by line supervision.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch007

Specialized Training

Concurrent with (or subsequent to) his indoctrination into a given company, the fledgling literature chemist today often receives special training in one or more of a variety of ways. Two thirds of the companies which answered the previously mentioned questionnaire indicated that they give special training to their new literature-chemist professionals.

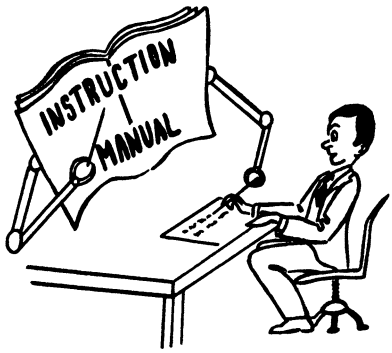


Sink-or-Swim Indoctrination. In the early days of the profession, a chemist became a literature chemist simply by being given assignments in the field and then being left to his own resources to carry them out. Usually, he had had some personal experience in the use of libraries, or in writing, or in whatever phase of literature chemistry was involved, but rarely had he had previous special training or an experienced supervisor to guide him. This sink-or-swim type of training still prevails in a number of organizations, with some modifications.

Today, it is not uncommon for a new literature chemist to be given a series of assignments of gradually increasing difficulty. For each assignment, he is given instructions that will enable him to carry it out satisfactorily, and his supervisor is available to answer specific questions, to edit reports, etc. Satisfactory development by this method depends chiefly upon the individual's ability to acquire the essential know-how on his own, through study which is not necessarily related to his present or past assignments.

Many superior literature chemists have been developed in this manner, since experience is a remarkable teacher, and the "bump of curiosity" of the average literature chemist is a large one, forever inciting his inquiry into new aspects of his field. An increasing number of companies, however, feel that a more positive program of training pays dividends. These companies now employ methods which combine movement through a variety of assignments with the use of instruction manuals, books, selected journal articles, and university courses.

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

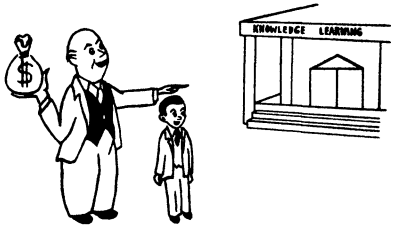


Instruction Manuals. Today, many companies have made style manuals available to their entire technical staffs. Even where this is not the case, it is not uncommon for the literature chemist to be provided with a style manual which delineates rules for writing, nomenclature, preparation of graphs and tables, report layout and duplication, and general typing instructions. For literature searchers, such special manuals also often include specific information on abstracting rules, techniques of searching, and basic sources -- information which will enable them to do their work in the manner specifically required by their company.

Where such manuals do not exist, the first literature chemist employed by a company usually finds it necessary to prepare them. Compilation or revision of portions of these manuals is a task sometimes assigned to the literature-chemist trainee.

In the recent survey of organizations thought to be employing literature-chemist professionals, one third of the companies reporting (half of those with special training programs) now provide their staffs with manuals on operational procedures, reporting style, etc. Other groups report plans to prepare such manuals.

Citation of Instructional Literature. Of the 22 companies which give special training to literature-chemist professionals, 19 stated that they refer new literature chemists to specific books, bulletins, and journal articles on information sources, documentation, and technical writing. Half of these companies count this their most important training technique.

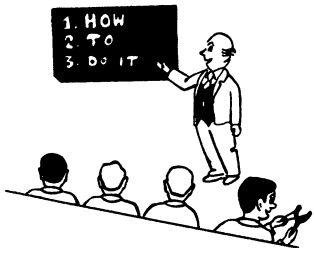


Encouragement to Take Additional Course Work. Many companies encourage their employees to take pertinent courses at nearby universities, so that they may acquire supplementary instruction in library techniques, literature searching, foreign languages, report writing, or related fields. If the employee takes these courses at the company's request, all of his tuition is usually paid. Employees who elect to take additional course work on their own initiative may receive part or all of their tuition, depending on the company. Thirteen of the twenty-two companies which provide special training to literature chemists pay all or part of tuition for pertinent university courses.

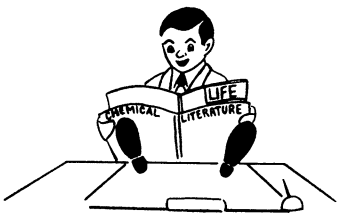
Encouragement to Participate in Appropriate Societies. The value of individual participation in appropriate societies, such as the ACS Division of Chemical Literature, the Special Libraries Association, and the American Documentation Institute, is well recognized; only one reporting organization which affords special training does not include encouragement of society participation as part of its program. Such participation is profitable to both employer and em-

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch007

ployee. The employee gains much valuable information and develops his professional status by attending meetings and taking part in the work of the technical and documentation societies. Such development is a tangible gain to the employer.



Provisions of Classes or Seminars on Related Subjects. Several organizations conduct classes of their own in literature-searching techniques and library operations; still more provide similar instruction in report writing. Formal, classroom-type instruction, coupled with practical assignments which are not merely teaching aids, provides the trainee with an excellent foundation in literature-chemistry craftsmanship. Eight of the companies reporting in the recent survey use regular classes or seminars as a training procedure.



Allowance of Time for General Reading. Self-improvement of the new literature chemist is fostered by allowing him time for general reading of documentation and scientific journals. Research chemists are well aware that very little of their current scientific reading will be of immediate value to them. This is also true of the literature chemist. Each reads to "keep up" and, hopefully, to gather a collection of impressions which some day may be recalled at an opportune moment. Reading of current journals is a technique employed by over three quarters of the groups which provide special training to their literature chemists.

Intensity of Training

Because the field of literature chemistry offers a wide variety of occupations - literature searching and abstracting, technical librarianship, technical writing and editing, patent work, market research--the type and intensity of on-the-job training programs differ according to the company's relative need for specialists in these various phases. An organization with a large documentation staff will usually require most or all of these specialists. Its training program, therefore, must be somewhat different for each of these positions. Its "graduates" will be literature searchers, technical writers, editors, abstracters, indexers, or translators.

Companies with smaller literature staffs, however, often cannot support such a comprehensive program. The degree to which they provide special services will govern the type of training given to a new employee. Frequently, he will be taught to render satisfactory performance in a number of specialties.

In the recent survey of organizations employing literature-chemist professionals, it was not possible to derive significant interpretations regarding the relative size, number of literature chemists, and scope of the training programs of the companies reporting. Fifty per cent of the companies reporting had less than 100 chemical employees; 25% had over 300. Approximately 140 literature chemists were employed by the 31 companies reporting.

Other Considerations

Training programs for literature chemists must achieve two goals: first, provide the necessary instruction in the basic methods of literature chemistry; second,

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In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

guide the employee in applying these and possibly more advanced techniques to the specialized needs of his employer. Industry will probably always find it necessary to provide the latter type of guidance, regardless of former training. The present shortage of trained personnel, however, forces industry also to supply the fundamentals--knowledge which might have been gained in school.

Those concerned with the administration of literature chemists have always recognized that theirs was an educational role as well as one of direction. Literature chemists are people, with natural drives, incentives, and desires. Women marry, have children, and (as a rule) eventually leave the profession. Many of those who stay, and many of the men who work in this field, sooner or later qualify for better positions which cannot always be provided by the companies for which they are working. As a consequence, a substantial degree of staff turnover is normal, not exceptional.

Incidentally, at least one research administrator is currently worrying about a shortage of qualified supervisory personnel for literature-chemistry programs. His concern centers around his theory that too many literature chemists become overly involved with details, an attitude necessary for high-quality individual work but not particularly conducive to developing a broad point of view and the ability to supervise others (and himself be supervised).

In commenting upon the training of chemical-literature specialists, several of those who responded to the survey put emphasis on the necessity for selecting good chemists to begin with. These individuals have placed their finger on the now-more-recognized fact that mediocre or even average technical training is not an adequate background for the literature chemist. Notwithstanding the contrary opinion frequently held in the past by some bench chemists and certain supervisors, technical competence in a subject field is essential to the literature worker.

Perhaps the excellence of technical training is not as important, however, as what it represents in terms of a superior ability to learn. All too frequently, the literature specialist operates outside of his fields of academic specialization. Industry often accommodates to this by affording possibilities for auxiliary training in fields of company interest. Receptiveness to such extra training, as well as the ability to acquire other subject information with experience, largely determines the eventual usefulness of the literature chemist.

Current advertisements for literature chemists frequently include the phrase: "Experience desirable but not essential." Just five years ago, experience was necessary and demanded. Here we see reflected the increasing, born-of-necessity trend toward "home-grown" literature specialists.

That this is not the single ultimate solution, however, is apparent from the efforts of both colleges and industry to foster and encourage academic preparation for the chemical literature and related fields. Notable among present efforts are the industrial library internships for M. L. S. candidates at The University of Texas and the science-journalism curriculum offered at Iowa State College.

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Employee Training Program of Ethyl Corp. Research Laboratories

The chemical industry has come to realize that universities cannot turn out graduates adequately educated in the fundamentals of science or engineering and at the same time trained to step immediately into any one of many specialized industrial jobs. This is true of literature chemists as well as other kinds of chemists. Most of the larger industrial concerns have also come to realize the value of a carefully planned program for the induction, the orientation, and the special training required to fit the new employee to his highly specialized job.

Ethyl's Program in Brief. The program that has been devised for newly employed professionals in the Research Laboratories of Ethyl Corp. at Detroit is broad

enough to cover literature chemists as well as other chemists and engineers. It consists in principle of the following:

1. Several varied job assignments, to which the new employee devotes 80 to 90% of his time for 6 to 12 months.
2. Various conferences, talks, and demonstrations which require 10 to 20% of his time and which acquaint him broadly with all areas of research activities at Detroit and to some extent, also, with the activities of other parts of the company.

This program is practical for chemists who are hired to fill immediate vacancies as well as for those who are employed 6 to 12 months ahead of anticipated openings in order to allow time for training. In either case, the director of employee development and training reviews the job assignments to guarantee that certain requirements are met.

First of all, the supervisor to whom the new employee is assigned must be qualified by both interest and ability to instruct, and a successful, experienced junior employee must be available to assist. Secondly, the training assignment must embody all of the elements of a regular project, one which will make effective use of the highest level of the employee's training and experience. It must also offer an opportunity to achieve substantial accomplishment and to enable a clear-cut appraisal of performance. Finally, the assignment's schedule must be sufficiently flexible to allow 10 to 20% of the employee's time to be spent in other activities.

Supplementing the job assignments are general orientation talks which present the over-all objectives of the Research and Engineering Department and its major divisions. More specific conferences, discussions, and demonstrations provide information on the functions, organization, and activities of about 20 individual groups and 10 major research problems. Biweekly, 1-hour technical seminars are followed by special discussion periods for new employees.

Training on an Individual Basis. Ethyl's program is based on conscious attention to the training of each individual in order to make him most effective on his present job and to prepare him for a more advanced assignment. As his immediate supervisor is frequently concerned only with his present job, it is necessary for a third person, the director of employee development and training, to attend to the requirements of future and more advanced assignments. It is possible for him to do much of this for new employees as a group, but in every case he has a careful regard for the needs of each individual, and he selects job assignments and other activities on that basis.

This requires a close coordination with the laboratories' recruiting and employing activities, in order to become aware of openings as rapidly as they arise and to become acquainted with prospective candidates when they visit the company for employment interviews. Planning for the individual begins as soon as the candidate accepts an offer of employment. It includes the induction procedures of the personnel office, assistance in finding housing and local transportation, as well as orientation in his working area and with his fellow employees. This policy of individual treatment is further demonstrated by having available several initial job assignments that are discussed with the new employee in terms of his qualifications and interest, thus enabling him to participate in the selection of his first assignment.

The immediate supervisor and the professional employee provide practically all of the orientation to the job assignment. They furnish background on the objectives of the assignment and indicate the first possible steps. They supply (or suggest how to locate) literature references, reports, and other information on this and related projects, and they outline the relationship of the assignment to the company's broad research objectives (and these, in turn, to its economic and business functions). Through them, the employee is introduced to other personnel and instructed in the functions and procedures of service groups. Safety rules, notebook and patent procedures, and report writing are also discussed.

The director of employee development and training confers periodically with

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch007

In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

Instruction of trainee in machine searching of literature files in connection with specific training assignment

Preliminary conferences impart information on objectives, accumulated knowledge, and functions of related groups (including service groups)

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In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

each new employee and his supervisor. He attempts to interest, encourage, aid, and follow up on the new employee in order to further his individual development along lines consistent with his ambitions and capacities. Such encouragement includes emphasis on membership in professional societies; attendance at their meetings (both local and nearby national); and suggestions for further formal education if desired or necessary. He assists in the employee's immediate development by checking on letter and report writing, including encouragement to do these by dictation; by demonstrating techniques of oral presentation in small-group meetings, including speech coaching if necessary; and by encouraging him to use the information in the files and literature, to do outside reading and study, and to visit other research laboratories and plants in the area.

On occasion, he reviews for new employees the special techniques involved in planning, programming, and conducting research, and in interpreting and presenting results. Less specific, yet extremely valuable contributions to the over-all development of the employee include informal discussions on human relations, communications with fellow workers and supervisors, and the intellectual disciplines and philosophies that govern industrial research.

Prior to establishment of this formal program, areas of training were determined by a comparison of the job assignments and experiences of all professional employees at Detroit with three years of company experience or less. This was accomplished through small-group conferences with employees and their supervisors. Many of the present duties of the director of employee development and training were established to meet the needs expressed in these conferences.

Typical Job Assignment for Literature Chemist. The preceding description, although general enough to show how the same program applies in principle to literature chemists as well as to other newly employed professionals, shows also that it takes a very broad program to avoid the shortcomings of the usual training.

1. Ethyl's program is not limited to lectures or to the reading of instruction manuals or other reference literature; these in themselves do not ensure communication.
2. It is not intended in itself to develop the individual but rather to encourage him and to provide him with the opportunities to develop himself.
3. It is not limited to courses or job rotation; all too often these simply afford observation with no actual problem situations or real participation.
4. It does not rely wholly on one or even on several supervisors, and it ensures that each supervisor is able and performs his part of the training program.
5. It ensures several worth-while actual-problem experiences, which can best be demonstrated by the following example.

One section of the Information Services Group has the responsibility for literature and patent searching, abstracting, and classifying. At present, this section contains three chemists and two stenographers. Accordingly, a new literature chemist assigned to this section for a problem experience would be able to work directly under both the section head and a professional literature chemist.

A typical assignment might be the preparation of a literature search on organic antiknock compounds containing a specific metallic element. The significance of the study--how it would fit into an evaluative research program and, if that proved significant, into the company's operations--would be explained to the trainee by a supervisor, in conference with a professional literature chemist engaged in the project's work. They would discuss the subject of metal-organic antiknocks, and would provide the trainee with background articles and reports. Similarly, they would describe Information Services' library facilities, general files, and files of abstracts, and would introduce the trainee to the staffs of the library, file room, and literature-searching section. They would suggest sources, reference tools, and preliminary plan of attack.

The literature-chemist trainee would then be given time to study the reference material provided, in addition to specific texts and manuals on literature searching

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In TRAINING OF LITERATURE CHEMISTS;
Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

(in general and at Ethyl). During this period, he would familiarize himself with the techniques and equipment being used for literature and patent abstracting and coding. When he had prepared a detailed plan of attack for his specific problem, the trainee would again confer with the project leader and section head for approval or modification, and would then set to work to carry it out.

This would involve searching the files of abstracts for information relative to his subject (using the available codes, indexes, and machines), following up on pertinent references by locating the original material in the files and library, and supplementing these references by a search of other secondary literature sources.

Finally, the trainee would summarize the information obtained in a formal report, written, edited, and duplicated in accordance with available manuals (provided for study) and duplication equipment (in the application of which he would be instructed).

Such an assignment would give the literature chemist basic instruction in literature searching and reference sources. It would familiarize him with company files and library resources, and with the individuals responsible for them. It would acquaint him with one aspect of the use of machines in documentation, particularly in relation to Ethyl data and practices. Finally, the assignment would familiarize him with and give him practice in Ethyl requirements for report writing and document duplication.

As the Information Services Group also has sections responsible for technical writing and editing, library and filing services, and graphic-arts services--all of them having literature chemists or engineers on their staffs--the literature-chemist trainee might then be assigned to one of these sections for his next project. For example, he might be assigned the preparation of a brief article summarizing Ethyl research in a specific phase of the automotive-petroleum field. This would enable the trainee to study and make further use of the files and indexing system, to meet technical personnel engaged in the field of research involved, to familiarize himself with the style and writing requirements of one or more journals in the automotive and/or petroleum fields, to gain practice in technical writing, and to learn to work well with technical editors and graphic-arts personnel.

A less exciting but highly valuable assignment might involve the subject indexing of lantern slides used by Ethyl speakers during the past year. This project would again serve to familiarize the literature-chemist trainee with filing methods, subject indexing in general, the fields of current Ethyl research (through the necessary study of the papers which the slides illustrate), and practices in visual aids (as demonstrated by the techniques shown on the slides themselves).

During these or similar assignments, the literature-chemist trainee would participate in the full (previously described) employee training and development program. Even if he were employed to fill a specific position immediately, much the same techniques would be brought to bear on his initial assignments.

Need for Continued Training

Unless industry actively promotes an awareness of opportunities in the chemical-literature profession among both university students and faculties, the shortage of literature chemists and the necessity for on-the-job training programs will probably continue to grow. All who have any interest in the useful role of the literature chemist must join in this effort. In the meantime, the chemical industry must continue and indeed amplify its on-the-job training efforts--a program which will never be completely obviated by any amount of prior training, because of the need for specific-company indoctrination.

Publication Date: June 17, 1956 | doi: 10.1021/ba-1956-0017.ch007

Basic Reading for Self-Training of Literature Chemists

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Received September 16, 1955.