parenthetically, that in our Section we have people who are fluent in German, French, Italian, Spanish, Hungarian, Schwyzer-Deutsch, and some of our people even know some Russian and a little Japanese.) Our FISG representative is an expert on literature searching and he directs state of art searches for patent purposes. He has traveled widely in Europe over the past five years, and Fig. 2 gives some idea of the areas he has covered.

One of our most verstile information specialists, the man in charge of the Structure-Activity Correlation Group (SAC), bears much the same relationship to published information on synthetic medicinal compounds as our natural products representative has to alkaloids or medicinal plants. Our SAC expert doesn't do as much traveling, but he directs a laboratory group in addition to his information functions, so there is no question of his keeping up his level of synthetic competence.

Other scientists in our section construct indexes to material not yet covered by published reports, compile indexes to organic reactions, and carry out a variety of other functions designed to permit the creative use of scientific information by both the laboratory scientist and the information specialist.

We may summarize by saying that the training necessary to produce an effective chemical information scientist, in our experience, is identical with that required to produce a really topflight laboratory research man. If we throw in the added seasoning of ten years of laboratory experience, plus the added spice of linguistic ability and foreign

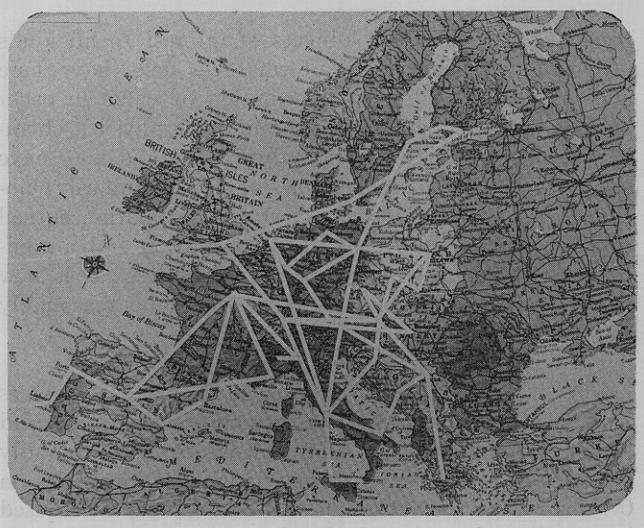

Fig. 2

travel, we will get a man who might meet our specifications. We would then have to determine whether he can write well, express himself clearly and, most of all, get along with his laboratory colleagues. If he does all of these things well he should be a credit to any research organization, if a competitor or the State Department does not snap him up first. He will then, if he is creative, go on to become a co-inventor on patents and a co-author on scientific papers, and he will find his scientific career richly diverse and satisfying.

On-the-Job Training at Chemical Abstracts Service*

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In general, producers of literature or information aids need the same kinds of training as do effective users of these aids. This mutual need varies in degree according to operations and to specific situations. The writing of this paper on the training of Chemical Abstracts Service (CAS) workers will proceed on the assumption that these differences in degree need not be pointed out.

In chemical-literature work, all need to know much chemistry, a good deal about languages, and considerable about information sources and documentation methods and tools. Primarily, CAS workers must learn about abstracting and indexing.

Many of the CAS workers acquire a *wide* knowledge of chemistry because, from the nature of the CAS work, the progress of chemistry continuously marches like a parade through the CAS office. This parade is marshalled and it must be closely observed by a considerable portion of the CAS workers. This kind of training occurs every day. Some of these workers must do a good deal of specializing in training and work because it is most efficient for biochemists to deal primarily with biochemistry, for organic chemists to work mostly with organic abstract editing and indexing, and so on, but all learn chemistry continuously.

For most of the CAS chemical work, as indexing, for example, college training to the M.S. and often to the Ph.D. stage is desirable as a beginning qualification. The opportunities for learning in the CAS work are so great as to make it possible for workers with lesser college training to acquire proficiency in it and to move up to highly responsible jobs.

The requirement for a broad knowledge of chemistry in addition to a degree of specialization cannot be overemphasized. The assigners of papers and patents for abstracting must be able to recognize chemical interest in the papers and patents examined (many are borderline), and to select the suitable abstractor in each case. The editors of abstracts must properly classify these as to subject matter and they must recognize the needs for cross references. These editors must learn also to recognize and correct all kinds of mistakes. The indexer, no matter what his field of specialization in chemistry may be, must

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recognize and index all subjects of interest to all kinds of chemists. Most papers, of whatever field, have here and there in them bits of information of value in other fields. Organic papers often contain some physical chemistry, a paper describing an analytical method may have a special industrial application, a paper primarily biochemical may be of real interest to the pharmaceutical chemist, and so on. Adequate specialization and a comprehensive and alerting acquaintance with what is new is also required, and fortunately also made reasonably easy from the nature of the task.

For the most part, abstractors specialize.

Chemical information is published in many languages (over 50). Abstractors must be found who collectively read all of these. Individual literature workers can reasonably be expected to master only a few languages. Statistics on *CA*'s coverage show that now the languages most used in recording chemistry are English (almost 50 per cent), Russian (about 19 per cent), German, Japanese, French, and Italian (in the order given), with all others totalling under 10 per cent. Without mastering the lesser used languages (far from that) the central-office CAS workers acquire ability surprisingly often to settle questions in abstracts by examining original papers appearing in a great variety of languages. Real facility with the more commonly used languages, either individually or collectively, is required in the CAS work. Much is learned by everyday exposure to many languages.

English is by far the most important language of all for CAS workers. This is attributable not alone to the predominant publication of papers in English. The staff collectively only needs to *read* understandingly the other languages; most staff members must be able to *write* or *speak* the English language properly and well for clear and otherwise effective abstracting, editing, indexing, letter writing, etc. Ability to express oneself well is of extra value for literature workers, whether they be occupied in recording and keying information for use by others or searching for information and writing reports thereon.

Carefully worked out, standardized nomenclature for science and technology is a significant factor in exact and clear communication. For indexing and other purposes CAS workers must systematically name thousands of chemical compounds and they must also familiarize themselves with the standard nomenclature of various branches of science other than chemistry. The use of good scientific nomenclature is a form of good English usage.

CAS workers must familiarize themselves with the sources of published chemical information. Books are abstracted only occasionally because as a rule they are organized assemblies of previously published information, but CAS workers must learn when this is not true (when the chemistry reported is new), and they must learn how to use many reference books in their work. These include encyclopedic works, handbooks, dictionaries, monographs, books of constants, and indexes.

The CAS workers deal primarily with periodicals as sources of original scientific papers. They must learn what to expect to find in several thousands of journals as to quantity, general quality, and publishing peculiarities. These workers must learn the characteristics of patents and how to dig new chemical information out of them. Patent language and practices often make this difficult. Then the CAS workers must be acquainted with, and make use of, many special publications such as government bulletins and trade literature.

In the CAS work there must be no lagging in learning of improved methods of dealing with chemical and other information. In fact, CAS has a reputation for many first in the invention and development of improved methods and it has a strong research and development division.

TEACHING METHODS

There are certain general characteristics of CAS' methods of on-the-job teaching of workers. In the first place the over-all picture of CAS' work and purposes is painted so that the beginner can more quickly grasp the general meaning and significance of the part he is to play. This helps interest to grow. Orientation training includes lecture and discussion periods with each department head explaining the operations and purposes in each phase of the CAS system of handling the chemical literature.

Then there is an attempt to share widely among the staff members pertinent and interesting information concerning the work, as new developments, happenings, objectives, plans, deadlines, hopes, and the like come along. It is felt that workers gain much in interest and in satisfying effort by knowing what is going on throughout the undertaking.

In addition to the whole picture the beginner is told as much as possible concerning his particular department and operation or task.

There are many written rules and sets of instructions for study and reference. The first day or two of a new worker is likely to be devoted mostly to reading.

The products of new workers are carefully reviewed by experienced workers who point out opportunities to do better. There is an understanding that this will happen and that the purpose is to help. Guidance varies with the abilities of the beginner; it goes on as long as necessary since the accuracy and effectiveness of *CA*'s record must be kept high and training must be thorough.

Meetings of groups occur with reasonable frequency. These have teaching value all along the line. The leaders gain new ideas and learn as they confer and teach. Evening lecture series by speakers from within and outside of CAS and ACS bring to the staff timely subjects on information work. Planned management and administrative workshop discussion periods are held to improve training in this area for those qualified.

In a small way teaching devices are used.

There has long been an effort to keep staff morale at a high level. This helps workers to grow. They try harder because of it. They are encouraged to feel individual responsibility for the collective effort, to strive for high standards of work habits, and to maintain maximum enthusiasm.

GETTING THE PUBLISHED SOURCES OF INFORMATION

This is largely library work. Training for librarianship is required for leadership in this work. The work calls

for the prompt obtaining of every publication needed from all corners of the world, for much record keeping, and for the early learning of new sources. A published "List of Periodicals Abstracted" is maintained with much useful information in it. The on-the-job part of the training for this work requires the active cooperation of all the more experienced workers ever alert for information on new sources of published new chemistry. Many eyes keep looking and the information spotted is shared.

ASSIGNING ABSTRACTING WORK

In the effort for complete coverage *CA* assignment and other workers carefully and regularly examine approximately ten thousand scientific, technical, or trade periodicals, the patents of twenty-three countries, and many special, irregular publications. An effort is made to have each abstract made by someone well versed in the chemistry of the field into which the paper or patent covered fits. The assignment worker must be able to decide as to chemical interest for borderline papers and, with the help of extensive records, he must decide who has the chemical knowledge, language-reading ability, and time to make a good abstract with reasonable promptness. The training for this work is a by-product of long experience in the editing of abstracts. There are written guides for some of the more troublesome situations, such as (1) Biochemical Borderline and (2) Criteria for the Inclusion in *Chemical Abstracts* of Material Near the Borderline between Chemistry and Physics. Collectively at least, familiarity with many languages is needed in the assignment work.

ABSTRACTING

CA has over 3,000 abstractors. Most are Americans, but there are abstractors scattered all over the world. The abstracting staff grows and changes. A difficult training problem is involved. This is lightened, however, by the fact that many abstractors stay on the job over long periods; it is our estimate that two-thirds of the abstracting for *CA* is done by less than one-third of the abstractors, all experienced, productive, faithfully good workers.

A new abstractor always receives a copy of Directions, a 52-page, indexed booklet containing 145 rules for abstracting, plus a special section for the abstractors of patents and one for abstractors of organic papers. The so-called rules cover assignments, the nature of the abstract, style, headings, *CA* and other references, forms and abbreviations, spelling, chemical nomenclature, and mailing. Abstractors, largely self-taught, are urged to study these directions carefully and to review them frequently as well as to use them for reference when in doubt as to procedure.

The editors pay special attention to the work of the newer abstractors and call attention to mistakes of commission or omission. Edited abstracts not infrequently are returned to abstractors, so that the abstractor in each case can see what the experienced editors thought it best to do in an effort for improvement. Even the more experienced abstractors sometimes are helped in this manner. Often there are accompanying letters of explanation and instructive request and always there is at least a note as to the purpose of the returning of an abstract. This step is usually taken after the abstracts have been printed, to avoid publication delay, though Verifax copies sometimes are sent at once. Also at times abstracts are returned to abstractors with specific friendly advice as to needed improvement instead of this work being done by the editors. Learning by doing has advantages.

In addition to many personal letters to abstractors, which have a good effect on morale while providing information, there are occasional general letters sent to keep all up to date as to CAS policies, plans, and activities. Promptness, accuracy, adequacy, conciseness, clearness, and other features of good abstracting all call for attention and friendly reminders help. Many abstractors retain copies of their submitted abstracts and compare these copies with the printed abstracts.

To enhance morale, to point out and emphasize good practices in abstracting, to provide information thought to be helpful and of interest to all, to call attention to needs, and to increase acquaintanceship, CAS issues, from time to time, a little house organ called *The Little CA*. Special effort is made to keep this little publication attractively readable with the belief that it has much teaching value while at the same time helping to keep the big, widely scattered CAS family more closely knitted together.

With the above helps, *experience is the great teacher.*

EDITING ABSTRACTS

The general pattern of the teaching of editors for abstracts is similar to that for teaching abstractors. In addition to the official directions to study there are hundreds of office memoranda (each editor has a file) with which to become acquainted as well as the ample office supply of reference books, dictionaries, special file cards, and the like.

Experienced editors follow up on the work of new editors as much as necessary. The editors read proof, with copy at hand, and they learn also by seeing what other editors have done. Then, too, they see the results of the editorial work of the section editors. Organized group conferences and more informal question-and-answer conferences between individuals help the editors to develop.

Among the most difficult operations for new editors to learn are the classification of abstracts and the making of cross references. Much experience is needed. The office maintains detailed classification outlines and memoranda. Misplaced abstracts discovered in proof reading are called to the attention of editors for teaching purposes. Deciding whether or not an abstract contains or refers to new chemistry and therefore belongs in *CA* is also difficult to learn. Statements as to the scope of *CA* and guided experience do the teaching.

INDEXING

Half of the effort in the CAS office goes into indexing. In the early years those who edited abstracts also did indexing in many instances (mutually good experience), but the indexing group now specializes.

CAS produces five kinds of indexes: author, subject, formula, patent-number, and organic ring indexes. All offer problems, but subject indexes present by far the greatest number of these problems and it will be necessary here to limit comment to subject indexing. Good subject indexing requires much knowledge, training, and experience. Only the exceptional new worker becomes reasonably effective at subject indexing in six months and it is not uncommon for several more months to be required for this. The indexing of chemical compounds, which requires special nomenclature training, will be discussed separately below. Indexing is done by dictation into magnetic recorders.

Subject indexing of *CA* can be divided into three main operations: (1) selection of subjects to be indexed, (2) the making of entries, which in each case involves choosing the heading and then wording the modifying phrase, if any, and (3) the editing of assembled index cards. Lesser operations are (a) the transcription on cards of the dictated entries, (b) the checking of the transcribed cards for accuracy, proper selection, etc., (c) the alphabetic assembling of the cards, and (d) seeing the index through the printing mill. Item (b) above might have been put with the main operations because a good checker must detect errors of judgment in indexing as well as transcribing mistakes.

For training, beginners are required first to study the *CA* Subject Index Introduction, the latest annual subject index, extensive subject indexing memoranda, and pamphlets on chemical nomenclature. They are helped also by studying the Directions for making abstracts if inexperienced in abstracting or the editing of abstracts. In particular beginners must thoroughly learn certain basic hard-core subject indexing rules which are underscored in the indexing memoranda. Oral instructions and conferences enter the picture.

There are special instructions for the editing of assembled index cards (a fruitful and very important operation) and often beginners, with follow-up work, are started at editing cards. As a matter of fact such editing is done for several purposes and beginners are expected to accomplish only the simpler of these purposes. This work gradually makes for familiarity in a rough way with what the indexers have accomplished. The beginner is likely to be put to the task of alphabetizing cards for a short while to take away some of the strangeness and to learn order intricacies.

Another early task is likely to be the checking of transcribed index cards with the marked proof in front of the checker. He can soon learn to check for accuracy of transcription, but an experienced worker must check also for possible mistakes in heading selection (or omissions of entries) and in modification dictation. It is good teaching to show changes to the new staff member. This is done with explanation. A variation is to do such checking with the beginner at the experienced worker's side. No new indexer is put solely on his own at indexing for a rather long time. Every stage of the beginner's work is checked and he is shown what he did wrong or failed to do.

We have spoken of new staff members starting work on advanced-stage operations such as the editing of cards. If index printing is under way at starting time for a beginner he may be put at proofreading with the index cards at hand for a while as a means of getting a little feel of indexing accomplishment. The proof is read after him by an experienced worker.

A beginning indexer is permitted, even urged, to put questions on the margins of the special wide-margined page proof which indexers use or to dictate questions for the transcriber to put on separate cards with the index cards. Even the thoroughly experienced indexers do this at times to get the benefit of the checker's views as to troublesome decisions. It is regular practice for indexers to put certain colored-pencil marks (follow-up indicators) on proof used for indexing when they need the help of a specialist, as one on the nomenclature of steroids. Marks for the formula indexer are also put on proof being indexed. There is a good deal of teamwork in the meticulous indexing of *CA* and the beginner as well as the eventual index user is helped by this.

As entries are made, except for organic indexing, underlining or writing on the margin is done to make clear what has been entered in the index. This helps beginners studying marked proof, later indexers who may be indexing like abstracts, and index editors who have occasion, not infrequently, to refer back to abstracts when they are puzzled about an entry. Collective index workers also are helped by this marking practice.

It will perhaps be clear from the above that the making of a good subject index worker, and of a good index in fact, is a long and difficult task. It is unfortunate that so many subject indexes are made by inexperienced indexers. So many index words instead of subjects, with resulting inconsistencies (scattering), omissions, and unnecessary entries.

INDEX EDITING

It has been expedient briefly to discuss index editing above along with the discussion of the making of index entries. Accordingly this separate section will be quite brief.

The first step is the alphabetizing of the index cards. This is not as simple a task as it may appear to be. Modifications as well as headings must be alphabetized and there are complications as to headings caused by position designations in the names of organic compounds and by the inversion of many such names. Also there are complications as to modifications caused by the fact that certain less significant first words are not counted in arrangement, and second indentures under headings call for separate arrangement. To gain skill in this work, beginners need a good deal of experience made effective by follow-up work.

Since there are hundreds of thousands of index cards in every semi-annual index and still more in collective indexes the alphabetizers must even study hand motion to save time. They use alphabetizing boards and some other devices to facilitate their work.

The editing of the assembled cards is a complicated operation the proper accomplishment of which does much to make the finished index good. A good subject index must be thorough, consistent, accurate, and conveniently usable. Since subjects, not words, are indexed there is opportunity in editing to do much to safeguard consistency. This is done in particular as to cross references. The cross references, properly used, contribute much to an index. With many entries thrown together under a given heading it is possible for a good editor to see frequent opportunities for improvement not recognizable when the individual entries are made. A subject index is built of words. There are often various ways of saying the same or like things. The index editor must recognize opportunities to combine entries with like meanings and to bring entries of similar meanings side by side. He must justify cross references or eliminate them.

The index editor must put the index copy in form for the printer with clear markings for indention and the like. Colored pencils and special markings are used. Then the index editor has opportunities to pick up errors. Order of entries must be checked.

Space here will not permit going into detail as to the editing operations or as to the training steps. This brief outline of index editing, so important for a good index, seems essential nevertheless in an adequate story of preparation for the accomplishment of the CAS tasks. Two teams are used: (1) less experienced workers do the simpler tasks and (2) experienced editors check their work while settling their questions and finishing the editing by performing the more difficult tasks. Problems of special nature, including those dealing with the systematic naming of organic compounds, are assigned to specialists. The beginners have nineteen pages of instructions. All editors work with the lastest printed index open to the place corresponding to the headings on which they are working.

There is an element of training all along the line in the work. The second survey editors train the first survey workers and all learn good indexing while editing the work of good indexers. For fuller information on this and other operations see "CA Today—The Production of *Chemical Abstracts*," published by the American Chemical Society, Washington, D. C.

INDEXING COMPOUNDS

The wise selection of compounds for indexing requires judgment, training, and experience. Inadequate selection leads to incomplete records of the literature. Overindexing dilutes the index with unneeded material and is expensive in terms of labor, printing, and other costs.

The systematic naming of compounds, especially organic compounds, is often a difficult task. The beginner must become familiar with a vast number of rules, principles, and indexing policies. These are designed in large measure to prevent scattering of individual compounds through the indexes under different names.

Often a compound can have several names none of which can be said to be incorrect and many times it is difficult to choose the name suitable for a consistent index. This difficulty may be due to structural characteristics which bring nomenclature principles into conflict with each other. An indexer has to become adept at selecting the names that most nearly conform with CAS policies and past practice. In other words, in order to become an accurate and rapid indexer, a person needs to acquire resourcefulness in solving nomenclature problems. This entails not only precise knowledge of nomenclature rules and formulated policies but also the ability to extend one's thinking into areas for which there are no stated rules or policies. It involves clear, analytical thinking, the ability to weigh one factor against another, and proficiency in searching previous indexes for precedence. Effective searching for precedence requires imagination and good knowledge of index construction. This knowledge can be acquired only through experience in preparation or use of the indexes. Often the answer to a nomenclature problem will be found at an index heading which is far removed from the name of the compound in question.

When a CAS worker begins his training in indexing, he is assigned a teacher. The teacher selected is always a capable, experienced indexer in whom the administration has a great deal of confidence. In the early stages of training the two people work together very closely as a team. The teacher checks all of the trainee's work. Mistakes are pointed out and suggestions made that lead to improved performance. These controls are gradually relaxed as the beginner gains in experience and skill. CAS has long had some of the nation's top experts in the field of chemical nomenclature. Helping to develop good standard nomenclature has been a factor in their training. Several staff members serve on nomenclature committees.

The *formula indexing of compounds* is tied up closely with their indexing by names. All that will be said about formula indexing here is the mention of the fact that accuracy in the figuring of molecular formulas for complex compounds, often with only names at hand, is an exacting attainment. Structures of organic compounds drawn to aid in systematic naming help in formula calculation. Training for this work includes the learning of such checking aids as the application of the odd-valency rule (the Laurent rule).

PRINTING

Little will be said here about printing as this is done for the most part as a separate job by the Mack Printing Company, which has its own training problems for handling chemical copy with its ring formulas and the like. The CAS workers, however, have to see *CA* through the printing mill by work on proof.

Proof is checked against copy for author and other proper names, references, numerical data, mathematical equations, and the like—for everything not readily

recognized as wrong when mistakes are made. This clerical operation calls for follow-up training to learn what to look for and workers are required to learn habits of alertness.

Final proof reading of *CA*, both abstracts and indexes, is a chemist's job, not a clerical task. The proof readers deal with concentrated scientific material and they must learn to detect and correct all kinds of mistakes, sometimes including mistakes in chemistry and presentation form overlooked by the editors. The reading of proof for *CA* is done by the editors of abstracts for the regular issues and by experienced indexers for the indexes. Training for this work is pretty much the same as the above-described training for editing abstracts and for indexing. There must be an additional period of training (mostly just experience) to acquire the ability to see every comma, letter, word, etc., while at the same time grasping meanings and noting forms of expression. Most new workers have had a life-long habit of reading rapidly for meaning only and really have not been conscious of the marks on paper which convey the meanings. Seeing everything down to detail with reasonable speed must be learned by prolonged conscious application.

CAS is going in for offset printing, as of its Formula Indexes. This requires composition to be done in the CAS office. Also the Research Department is building files of all compounds and related data for handling by computers. The coding of organic structures involves the use of the official system of Notation for Organic Compounds of the International Union of Pure and Applied Chemistry. These and other tasks require special training, as computer school sessions and Varityper school work on the outside along with internal training.

PREJOB TRAINING

On-the-job training is perhaps necessary in just about all more or less extensive undertakings. Employers hope for considerable prejob training in hiring workers, and workers usually benefit when such preliminary education has been available and has been experienced. CAS usually has been unable to find workers with prejob training in abstracting, editing, and indexing. With the growing recognition of the importance of adequate utilization by scientists of the rapidly filling world's storehouse of research information, it is hoped that college training courses in the chemical literature field will increasingly include work on the production of searching tools as well as on their utilization. All would benefit. Whether or not students plan to go into chemical literature work, this kind of training would be helpful. Literature-handling services would gain in proficiency to the benefit of all and utilization of them would gain in efficiency. The best gatherer of grain is the man who knows the farmer's whole task.

Education of Information Personnel*

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This paper is not intended primarily to reveal new factual information about literature chemists and their training. Rather, the purpose is to tell about what we hope will be a significant influence in the near future.

Since October of last year the Georgia Institute of Technology has been conducting a program to study the Training of Science Information Specialists. The study is sponsored by the National Science Foundation, and is directed by Mrs. J. H. Crosland, Director of Libraries.

Three types of specialists are included within the scope of the program, Science Librarians, Technical Literature Analysts, and Information Scientists, and they are defined as:

(1) **Science Librarian.**—A libarian with a broad though not necessarily deep acquaintance with science and a comprehensive knowledge of the literature of science. He differs from the literature analyst in two respects: (a) He is a librarian, and therefore qualified to deal with all the usual problems associated with the operations of a librarian, and (b) while he can and does perform literature searches, he cannot in general critically evaluate the scientific content of the literature.

(2) **Technical Literature Analyst.**—One who is trained in a substantive technical field, who has, in addition to the depth thus provided, some breadth of technical knowledge, and a thorough knowledge of the technical literature. He can analyze the literature for researchers who are investigating problems in the areas of the analyst's technical competence. Analysis implies a search, an organization, and an evaluation of the literature in question. In his ability to deal with the technical literature the analyst differs from the conventional science librarian in that his knowledge of science is sufficiently deep for him to make value judgements of its literature.

(3) **Information Scientist.**—One who studies and develops the science of information storage and retrieval, and who devises new approaches to solutions to information problems.

Our study has been divided into two halves, long-range and short-range approaches to training. As the name implies, the short-range activities are intended to help solve immediate problems. In particular, this plan includes short courses and in-service training programs. These two programs are linked because they are intended primarily for people who already are involved in information work. The length of a short course is not defined; we have sometimes been inclined to define them as non-degree

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