ISI's Experiences with ASCA—A Selective Dissemination System*

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ASCA (Automatic Subject Citation Alert) is a commercially available SDI system covering the journal literature. The repertoire of questions which ASCA can utilize includes cited references, words from titles, authors, organizations, etc., and allows fer logical combinations of these questions. This paper discusses differences and similarities between "citations" and "words" in retrieving and disseminating information. The problem of user-system interaction is explored, and some techniques for developing affective interest profiles are described. Although ASCA is a multi-disciplinary system, examples from flotds like synthetic chemistry and biochemistry are provided.

During the past three years, the Institute for Scientific Information has been testing and operating the first largescale selective dissemination system commercially available to individual scientiste. During this time, researchers in almost every discipline have been utilizing the ASCA (Automatic Subject Citation Alert) system. More than 500 scientists have been involved in the tests of ASCA files that cover approximately 300.000 current articles each year, requiring about 10 million indexing terms.

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Many systems for the selective dissemination of information (SDI) have been reported. Most of these systems are designed to provide information to individuals in

specific large organizations like IBM, NASA, etc., which ordinarily already possess large-scale computers. For this reason, until now most academic, industrial, and governmental scientists and administrators who could benefit from SDI systems have not. ASCA has changed that situation and puts SDI at the disposal of anyone in large or small organizations.

ASCA has substantial coverage of chemistry and allied fields and has much to offer chemists who want to "keep up" with the literature. Of the 1600 journals covered by ASCA, perhaps the largest segment, beside physics and biomedicine, deals predominantly with chemistry.

Each journal covered is completely indexed as it is ISI's policy to cover journals comprehensively. Selective segmentation of journals or parts of journals into a priori categories, as is done in most conventional disciplineoriented systems, usually results in loss of information for the user. One of the significant advantages of the *ASCA* multidisciplinary approach is that it integrates the literature of seemingly diverse disciplines. Rapid technological advances in many cases involve mixtures of disciplines. *ASCA* enables the scientist to be aware of and take advantage of this cross fertilization.

In 1965 ISI launched its ASCA system (ASCA I). For the past two years we have had operating experience with ASCA I, ASCA II, and now ASCA III. The main differences between each succeeding generation of systems have been (1) new searching capabilities, (2) lower costs, and (3) added conveniences for the user. Simultaneously, journal coverage has been rapidly expanded.

ISI publishes the Science Citation Index (1), which covers about 1600 journals, including most of the significant chemical journals of the world. The input to the ASCA system is exactly the same as the input to the Science Citation Index (SCI). However, there are significant differences in the manipulations and outputs. For ASCA, output is a series of individual weekly reports of data selected on any of a vast repertoire of indexing criteria. For SCI, the output is the camera-ready copy of the large alphabetized Citation, Source, Corporate, and Permuterm Indexes.

ASCA was developed after 10 years of research on a retrieval system called "citation indexing" (2). The citation indexing method of retrieval of subject matter is based on the fundamental idea that when a scientist cites an earlier work, he specifies a conceptual—that is, subject—relationship between the two papers. In brief, he indexes his paper by use of citation terms. Later, when the user of a citation index or ASCA expresses his subject interest in citations (cited references) rather than words, the semantic problems frequently associated with changing nomenclatures or complex descriptors are avoided completely.

In all SDI systems it is necessary for the user to construct a "profile" of interests (3). He must "ask" the system what he is interested in. The computer, in turn, will "answer" the user by stating which current articles have appeared that should be of interest. The computer does this by comparing the user's profile with the attributes of the individual source documents.

In the ASCA system, the user has several advantages not found in other SDI systems (4, 5). He can construct his profile in many different ways and can use, emong others, citation and/or word profiles in building his interest profile.

As examples, questions to the ASCA system can include requests for articles which:

- contain in their titles any specific words, initial parts of words, or phrases, either alone or in any conceivable combinations.
- 2. are written by a given author.
- 3. describe work done at a given organization.
- are published in a given journal.
- cite any given paper, book, thesis, patent, etc.
 cite a given first author.
- conform with any combinations of the above.

Each weck the newly published literature of science and technology is screened by ASCA and matched against each individual profile submitted by each scientist. To get an idea of the magnitude and complexity of the ASCAsystem, consider that in an average week, the computer examines about 6000 newly published items characterized in detail by some 180.000 indexing terms. including among others 60,000 cited references, 68,000 cited and publishing authors, 37,000 keywords in titles, and comultes thousands of word stems, word phrases, and combinations thereof.

An important factor in the success of any SDI system is that it must allow the user to communicate with the system readily. This is true of ASCA. Users are provided periodically with cumulated statistical tabulations of their weekly ASCA reports. The user can add to, delete from, or reshape his profile on a weekly basis. This interaction between man and machine enables ASCA not only to be efficient, but constantly self-correcting.

Another factor which affects the success of an SDI system is the ease of access to the documents that are retrieved—that is, listed in the weekly reports. The ASCA subscriber can receive, together with his weekly ASCA report, tear sheets of articles listed on his report. This is called ASCAmatic service and is purely optional. Alternately, the user may order any article on his ASCA report by using ISI's Original Article Tear Sheet (OATS) service. The specified tear sheets will be mailed within 24 hours of receipt of the "Return" copy of his ASCA report. ISI's unique OATS library consists of multiple copies of journals from which articles are literally torn hence, the name tear sheets. Tear sheets of all but the longest articles are obtained quickly for \$2.00 per article.

ASCA computer reports are sent by first class or air mail each week. Even if the literature does not provide any "hiti" in a particular week, the subscriber still receives a report assuring him that the computer file was searched but that no pertinent items were found that answered any of the questions in his profile.

The frequency of ASCA reports makes it possible for any subscriber to read his report in a matter of minutes, an important factor to the busy scientist. The number of "hits" will vary from week to week and from interest to interest. Each ASCA report is quite individualized. Even two people working on similar projects generally have specific approaches which may differ considerably.

While words are inherently ambiguous in any system, and especially in so-called thesaurus systems, citations provide a means for defining subject interests relatively free of ambiguity (6). An example which illustrates the advantages of citation indexing over word indexing is the

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topic of "Chemical Evolution" ("Origin of Life"). In this instance, there are practically no existing terms which will permit the scientist to construct an adequate word profile. Nevertheless, an average of half a dozen pertinent papers are found each week through the use of key cited references and authors.

There are other subjects, however, for which the user's requirements can be satisfied better through a word profile. This becomes apparent in fields where the terminology is unambiguous, free of inadvertent homographs, and where this terminology is consistently used in titles to identify the main theme of the article. The word "laser" is an example of relatively "clean" terminology. Words also can be used to advantage in fields where there are poor bibliographic practices or where there is a tendency to use small bibliographics or a diffuse bibliographic heritage. The field of engineering illustrates an area where references are not presently used as much as they might be. "Communication systems" illustrates a topic which might be difficult to specify in a list of cited references.

In our experience, one of the most exciting aspects of using profile terms such as "communication," "reading," or "creativity" is serendipitous "fallout" which is, in fact, inseparable from "noise." Users frequently find those things "interesting" which indexers would have ruled out as being "not relevant." In practice, it is all but impossible for an indexer to determine on an *a priori* basis all articles which prove "relevant" to the highly specific and subjective requirements of a particular user at a later time. This is especially true when the indexer is an intermediary applying either restricted or unrestricted vocabulary to an article as in the Index Chemicus or Current Contents. Chemical Sciences. It is also true for the original author when he "indexes" his paper by the title he chooses and by the references he cites.

Keep in mind that it is not always easy to ascertain what is irrelevant. Two different users may react differently to the same information. Some readers are often glad to see articles which other persons might consider irrelevant.

In the sense that the natural language expressions of authors form the basis of the word selection procedure in ASCA, it is a natural language system. In contrast, systems such as MEDLARS are based on artificial "unnatural" language - that is, subject heading authority lists or thesauri applied by indexens (7). Each of these approaches has advantages and disadvantages, but it should be stressed that in the ASCA system, word profiles are used to augment, not to replace, the unique means of access to the literature through citation indexing.

Figure 1 is a composite ASCA report illustrating answers to various types c! questions. To illustrate the ASCA service by actual example, the profile for an industrial chemist doing research on "dimethylsulfoxide" is shown in Figure 2. The profile contains key papers on this topic, as well as the word terms "DMSO" and "dimethylsulfoxide." Figure 3 is a partial list of selected items to which the researcher was alerted during the past year. The items selected illustrate "hits" based on cited references and/or the terms "DMSO." etc.

ISI began the ASCA service after having had considerable experience with the publication of citation indexes. The 1965 version of ASCA is now designated as ASCA

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Figure 1. A composite ASCA report.

I. It was limited to the extent that the major type of question that could be entered in the system hinged upon the formulation of a list of "starting references" or known published works of interest. Thus, in the ASCA I system, having provided a list of key references in his field, a scientist would be alerted to all subsequent current papers that cited any one or more of the papers in his starting reference is the so-called "Cited Author Question," in which the scientist is alerted to any paper which has cited any of the papers ever written by a given first author.

After considerable experience with ASCA I, ISI made a number of modifications in the system and increased the versatility in what we now designate as ASCA II. In this stage of its development, source author questions, organization questions, patent classification, and patent assignee questions were introduced, adding considerable flexibility to the system. A "Source Author Question" serves to identify current papers published by a given individual no matter where his name appears in the by-line and regardless of what it cites or doesn't cite. Thus, if you know that a particular scientist is regularly working in a field of interest, it stands to reason that papers

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Figure 2. ASCA profile on dimethylsulfaxide.



Figure 3. Part of weekly ASCA report on dimethylsulfaxide.

which he publishes will probably be pertinent to your interests.

ASCA II enabled users to enter an "Organization" question so they could receive weekly reports on all publications emanating from a particular industrial, academic, or governmental organization. One can understand why a given chemical company might like to be informed regularly of all papers published by scientists affiliated with a given competitor. But the "Organization" question also is used to monitor the publications of one's own organization or to foster the exchange of information between academic institutions and the industrial firms in the area.

As in all SDI systems, ASCA I and II, while providing a unique means of access to literature through citation indexing, demanded of users a form of self-discipline, in framing questions, to which they were not accustomed. In traditional searching systems, where the chemist is directly involved in the searching, this rigor is not required. Furthermore, as SDI reports are quite selective, the user is afforded less opportunity to browse than when using Current Contents or the indexes to Chemical Abstracts or Index Chemicus. Consequently, the searching process of an SDI system must be "programmed" carefully by the user, and provision must be made to implement changes as needed. Whether the indexing methodology employed is citation indexing, thesaurus-controlled indexing, title indexing, etc., the key element in the success of the SDI system is the perceptiveness with which the profile is constructed and adjusted.

The introduction of ASCA III in late 1966, whereby "Cited Reference," "Cited Author," "Source Author," and "Organization" questions were augmented by "word profiles" did not alter this basic requirement. Indeed, the discipline required on the part of the user in constructing word profiles may be even more rigorous in some cases. "Cited Reference" questions can frequently make up, through redundancy, what is difficult or impossible to resolve when working with the innate ambiguity of natural language.

In ASCA III, we have an extended hybrid system in which it is possible to employ citation, author, organization, journal, and word profiles. All of these may be searched in a variety of combinations that will be illustrated later.

With ASCA III a subscriber can readily alter his profile by additions or deletions—and in most cases without charge. He now can do this on a weekly basis. Twice during each subscription period, he is sent a form which he can use at any time to make unlimited deletions from his profile and which will be done free of charge provided he uses the forms provided. This flexibility is necessary because no one is able to anticipate all possible useful terms, and furthermore, interests change.

In a paper presented two years ago in Syracuse (8), I provided a rather lengthy comparison between citation indexing and word indexing. It is not possible to elaborate in detail here on the many differences and similarities between these two types of indexing: however, there are some general comments which must be made: In one review of an early Science Citation Index, a British scientiat (9) claimed that, given comparable financial support one could, through traditional indexing methods, produce a word index that would be equally as effective as a citation

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index in retrieving information. He tacitly assumed that every concept which the mind of man can conceive is reducible to some simple set of indexing words.

Chemists know how difficult it can be to express structures, reaction mechanisms, mathematical equations, etc. in words. Ultimately, most concepts, if researched long enough, are clarified so that they are more amenable to expression in natural terms: but, particularly in chemistry, we are frequently dealing with concepts which cannot be easily described. That many chemists deal frequently with chemical compounds tends to obscure the fact that they and other chemists also deal with less easily labeled phenomena. Thus, benzene, carbon tetrachloride, or even some complex polymer can be stated in seemingly unambiguous terms through a chemical name. But in the early stages of work with naturally occurring substances, this is not possible. Similarly, chemists try to understand reaction mechanisms, but clearly there are many chemical states which cannot be reduced easily to verbal tags and remain, even after they have been elucidated, difficult to reduce to linear linguistic expressions. That is probably why a word-oriented index system like Chemical Abstracts Index cannot effectively cope with indexing reaction mechanisms or similar concepts.

However, if one wishes to find literature in which a particular reaction mechanism has been discussed, it is relatively easy to do so via a citation index. Similarly, if a given chemiat wants to know of all currently published papers in which that reaction mechanism is discussed, ASCA can provide him with weekly reports of such information by telling him all papers that have cited the first paper, or one of the other papers that the chemist might be familiar with which were concerned with this reaction mechanism.

This is illustrated in a search of the Science Citation Index conducted by a British organic chemist who was interested in determining literature published since 1960 concerning the "hydrolysis of hindered esters by lithium halides in pyridine" (10). In this search, the starting reference was a paper on the Eschenmoser hydrolysis.

Figure 4 shows the list of papers that would have been sent to an ASCA subscriber in 1966 interested in following this literature. Figure 5 lists the papers retrieved from the Science Citation Indexes prior to 1966.

"Chemical Evolution" was mentioned earlier as another example of a difficult-to-define chemical topic. There is, as yet, no adequate list of terms that would enable even the most versatile chemist to determine, in an a priori fashion, which current papers should be sent to a chemist who is interested in all aspects of this topic. This is illustrated in Figure 6, which shows a number of appropriate titles sent to a scientist interested in the topic of "Chemical Evolution." It is evident that the titles of the papers would suggest the notion of Chemical Evolution only to the sophistcated.

Thus, our experience with ASCA confirms that there are many fields or topics for which it is difficult, if not impossible, to create word profiles that will satisfy adequately the needs of the requester, regardless of whether the indexing system involved is based on a selection of words from titles, abstracts, or even complete texts.

On the other hand, again particularly in the field of chemistry, there are examples and reasons why citation

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Figure 4. 1966 articles retrieved by ASCA concerning hydrolysis of hindered esters by lithium halides in pyridine (Eschenmoser hydrolysis).

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Figure 5. Papers published prior to 1966 on the hydrolysis of hindered esters by lithium halides in pyridine (Eschenmoser hydrolysis) retrieved through the Science Citation Index.

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Figure 6. Some papers retrieved by ASCA concerning chemical evolution (origin of life).

indexing will not be completely adequate for getting at certain other types of information.

Suppose a chemist is trying to synthesize a particular chemical compound. If this compound has never been reported in the literature before, it may not be practicable for the chemist to identify starting references that would be necessarily identified with that compound. If the title of a paper were, for example, "The First Synthesis of Pentafluoropyridine," one might assume that ASCA could only report this paper through a term like pentafluoropyridine. However, the chemist could learn of such a paper through citation indexing, if, in fact, he could anticipate the possible procedures of synthesis that might be employed in order to produce such a compound. Thus, when this particular chemical was indeed first reported, the authors of the paper cited a well-known method for synthesizing fluoropyridines. This earlier paper would have been a logical starting reference in a citation profile. Nevertheless, it is not unreasonable to assume that some other completely unique method for synthesizing the compound might also have been cited, which our chemist might not have anticipated. That papers published in chemical journals cite from 10 to 20 references, and thereby provide a considerable redundancy, does not alter the basic problem that in this type of situation word profiles may be preferred to citation profiles.

Thus, the introduction of word profiles in the ASCA 111 system, by which it is possible for the chemist to stipulate that he should receive alerts to papers containing in their titles a particular word, word stem, or word phrase, adda considerable flexibility to the ASCA system. By adding this feature to ASCA, however, we must he alert

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to the danger that inherent inertia on the part of the scientist to avoid the self-disciplining process in preparing profiles may result in the omission from his profile of the less ambiguous "Cited Reference" questions which could make his over-all profile far more effective.

One reason why a citation profile can be more precise than a word profile is the ability of the "Cited Reference" question to delineate clearly a relatively small part of the total literature. Consider a topic as broad as DNA. There were more than 1000 papers published in 1966 that contained this term. In order to identify a subset of the information on this particular topic, one has a choice of specifying, by means of a citation profile, a group of papers on a particular aspect of DNA research. Alternatively, one can stipulate that "DNA" must appear in the title in combination with some other term or terms. Thus, if one is doing work on the DNA content of the brain, the ASCA search could retrieve only papers containing both the terms "DNA" and "brain."

This leads to a discussion of the capabilities of the ASCA III system by which it is possible to phrase ques-



Figure 7. A Boolean statement illustrating one of the ways that logical relationships

may be expressed in ASCA.



Figure B. Use of simple type indicator instead of Boolean statements.

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tions involving any complexity of Boolean expressions. Thus, Figure 7 shows how a British user expressed his ASCA question. The question is also expressed in the more familiar notation of the logicians. However, most ASCA word questions are quite simple.

The best way to demonstrate how ASCA employs word profiles is to show a few examples (Figure 8). Type 1 terms are those which cause an alert when at least one of such terms occurs in the title. The Boolean expression is, therefore, 1 or 2 or 3 or 4 or ...

Type 2 terms are those where two terms involved must co-occur in a title but not necessarily consecutively. The Boolean expression is (1 and 2) or (1 and 3) or (2 and 3) or... This, of course, can be extended to three or more terms. A term may be either a specific word, a word phrase, or an initial stem of a word or word phrase.

Negation is also possible. A reader, for example, may read a particular journal regularly and will specify that alerts shall be suppressed for items published in that journal. More frequently negation will be applied to a word to help reduce the amount of fallout and/or "noise" which may result from employing other ambiguous or more gen-



Figure 9. Example of a "Chinese Menu" combination type question.

eric terms. For example, an information scientist might use the term "information" but specify that papers on "genetic information" shall not be retrieved.

A convenient device is the "Chinese menu" type of question (Figure 9). The Boolean expression for such a question is (1 or 2 or 3) and $(4 \text{ or } 5 \text{ or } 6 \text{ or } \dots \text{ or } 16)$.

The ASCA III system is able to handle numerous other types of questions and combinations of questions. Our problem is not, "How can ASCA III meet an unusual requirement?" but more often rather, "How many of the almost endless variety of questions available in the ASCA III repertoire dare we try to describe without hopelessly confusing the user?" Only a small number of users are vitally interested in Boolean algebra. All they want is the pertinent information with the least effort.

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