the two processings are compared in detail. This procedure enables identification of the types, causes, and sources of undetected errors. The sampling procedure is not designed for the detection of errors. The fact that it does detect them is purely incidental.

As users of chemical information we understandably desire the elimination of all errors in both primary and secondary publications. However, as representatives of an organization which must recover the costs incurred in producing its publications, we must concede that some errors will exist in the published literature. CAS is striving, wherever possible, to reduce the number of errors in its publications and to make appropriate reference to errors which are detected in the primary literature we cover.

Control and Elimination of Errors in ISI Services*

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The Institute for Scientific Information produces several indexes and abstracting and alerting services which contain error-controlling features. *Curent Contents, Index Chemicus* **have different and unique mechanisms for finding and correcting errors that have appeared in the primary literature and those generated during their production of these secondary publications. Aspects of error control in these publications will be discussed.**

Current Contents, Index Chemicus (IC), *Science Citation Index* (SCI), and ASCA (Automatic Subject Citation Alert) each have different and unique mechanisms for finding and correcting errors that have appeared in the primary literature and those generated during the production of these secondary publications.

It is obviously only possible to state very briefly some of the problems that exist, as well as some of the methods that are used to overcome them. This paper illustrates some types of errors involving people, other types involving machines, and, finally, general or composite errors.

The error-checking methods vary in complexity and extent according to the circumstances. For example, in the production of the *Index Chemicus*, not only are the articles indexed and graphically abstracted, but the molecular formulas of the individual compounds described by each author are recalculated by trained chemists. These abstracts are then sent to the original author for approval, giving him the opportunity of confirming corrected errors or making additional changes. Thus, the data found in *Index Chemicus* are sometimes more accurate than in the original article from which the abstract was prepared.

There is another important aspect to the whole problem of errors in the literature. Consider the perpetuation of a mistaken method or data that can go on being used for years without knowledge of subsequent modification. It is one of the unique capabilities of the *Science Citation Index* system that a straightforward check of the indexes will reveal such "corrections" (Figure 1).

An example of what one error in *Current Contents* can do is the case of an article by D. M. Baron of London,

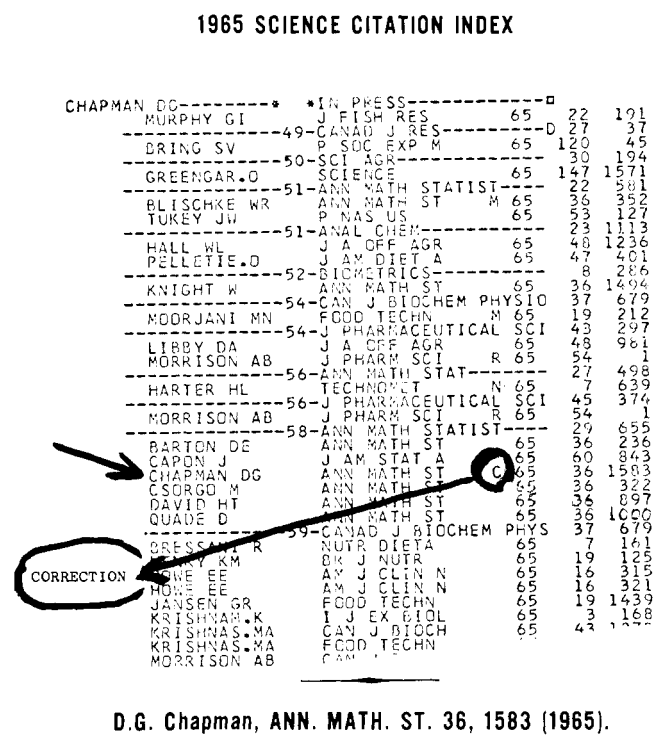

Figure 1. Actual correction note by Chapman citing original 1958 paper.

* Presented before the Division of Chemical Literature, Symposium on Error Control in the Chemical Literature, 151st National Meeting of the American Chemical Society, Pittsburgh, Pa., March 23, 1966.

England. We intended, with Professor Baron's consent, to present his address in a slightly modified form in the address directory of *Current Contents*. This coding was to enable him to recognize those reprint requests which came to him through users of the author address directory in *Current Contents*. However, the address for Professor Baron was listed in *Current Contents* as Athens, Greece, instead of London, England. By coincidence there happened to be a Dr. D. Baronos in Athens, Greece, who eventually received 17 reprint requests. Dr. Baronos was kind enough to forward these to Professor Baron and enable us to complete the experiment.

An example of a mechanical aid that can be helpful in checking for errors is the HydroBond Computer, a circular slide rule invented at ISI, and used by the chemist-indexers when recalculating molecular formulas of newly reported compounds (*1*). This hand calculator provides a simple checking procedure that can also reveal when an indexer may have inadvertently selected the wrong Markush group for a derivative (*2*).

In addition, the electronic computer and automatic typewriter are used to check for errors in the molecular formulas which might be introduced during keypunching—for example, errors in the spacing between chemical elements.

The large-scale data processing associated with the preparation of the *Science Citation Index* provides numerous opportunities for correcting errors that have appeared in the literature. For example, in a paper by C. L. Standley published in the *Journal of Applied Physics* (*3*), reference was made to an article by C. A. Mead (*4*) which had appeared earlier in the *Physical Review*. However, in Standley's article, this reference is erroneously cited as having appeared in the *Journal of Applied Physics*. This was brought to our attention through a phone call from a researcher who was trying to find the elusive article

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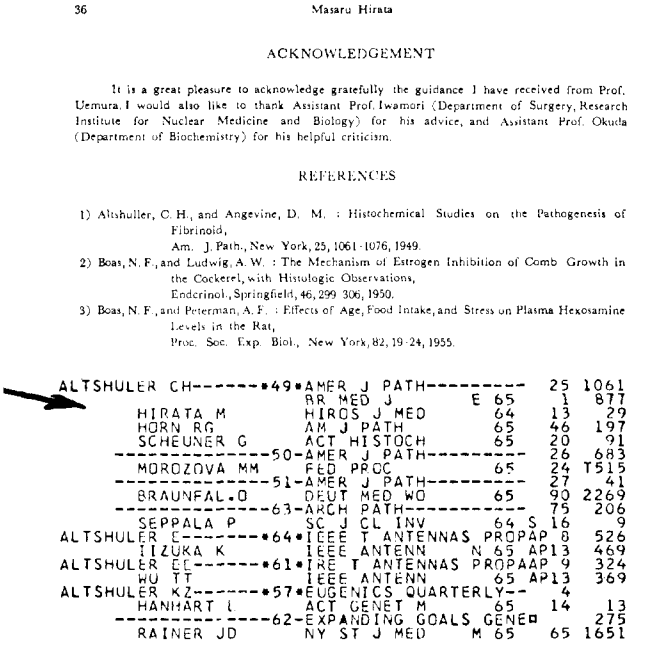
MEAD CA----------61-J APPL PHYS--------- 32  646
      CHAPMAN RA      J APPL PHYS      64   35 2832
      CHRISTY RW      J APPL PHYS      64   35 2179
      COHEN J         J APPL PHYS    N 64   35 3056
      FORLANI F       NUOV CIMENT      64   31 1246
      HARRIS LA       J APPL PHYS      64   35  268
      HARTMAN TE      PHYS REV.A       64  134 1094
      MANN HT         J APPL PHYS      64   35 2173
      RHODERIC.EH     BR J A PHYS      64   15  613
      STANDLEY CL     J APPL PHYS      64   35 1530
    ----------61-PHYS REV LETTERS----   6  545
      BASHARA NM      IEEE COMP P      64 CP11   4
      BASHARA NM      J APPL PHYS      64   35 3498
      KU HY           J APPL PHYS      64   35  265
      POLLACK SR      J APPL PHYS      64   35 1503
    ----------62-J APPL PHYS----  ---- 128 2088
      STANDLEY CL     J APPL PHYS      64   35 1530
    ----------62-PHYS REV LETTERS----   8   56
      BERGLUND CN     PHYS REV A       64  136 1044
      HARRIS LA       J APPL PHYS      64   35  268
      MOTIZUKI K      J PHYS JAP       64   19  486
    ----------62-PHYS REV LETTERS----   9   46
      MOTIZUKI K      J PHYS JAP       64   19  486
    ----------62-PHYS REV---------- 128 2088
      BASHARA NM      IEEE COMP P      64 CP11   4
      HARRIS LA       J APPL PHYS      64   35  268
      HARTMAN TE      PHYS REV A       64  134 1094
      HICKMOTT TW     J APPL PHYS      64   35 2118
      VANDERZI.A      J RES NBS D    M 64 D 68  660
```

Figure 2. Page from SCI showing Standley's erroneous citation of reference article.

by Mead. As shown in Figure 2, the error was immediately exposed by examination of the citation index entries for C. A. Mead (*5*). The erroneous citation precedes five correct references to the same paper. The true identity of the incorrect reference can be deduced because of the coincidence of the cited author, year, volume, and page. In this particular instance, the automatic computer correction routine we employ leaves the error unchanged. On the other hand, the logic of the computer programs we use actually does modify and correct most literature errors of this type in such a way that the user of the *Science Citation Index* would never know that Standley had, in fact, cited the paper incorrectly. Thus, citation errors rarely result in a complete loss of information.

Figure 3 illustrates an occurrence of an error in the literature which *is* automatically corrected by the computer during preparation of the *Science Citation Index* (*6*). The article by Hirata (*7*) misspells C. H. Altshuler's name when citing the 1949 work from the *American Journal of Pathology* (*8*). When other correct citations to the same work are brought together with the error, the correction procedure modifies the incorrect spelling so that all the citing works appear properly together under a single header for Altshuler, spelled correctly. This unification procedure selects the most correct version of the cited author's name and cited publication title independently from each cited work. The unification does not extend across different cited works.



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ALTSHULER CH------*49*AMER J PATH---------  25 1061
                    BR MED J          E 65   1  877
      HIRATA M      HIROS J MED         64  13   29
      HORN RG       AM J PATH           65  46  197
      SCHEUNER G    ACT HISTOCH         65  20   91
    ----------50-AMER J PATH---------  26  683
      MOROZOVA MM   FED PROC           65  24 T515
    ----------51-AMER J PATH---------  27   41
      BRAUNFAL.O    DEUT MED WO         65  90 2269
    ----------63-ARCH PATH----------  75  206
      SEPPALA P     SC J CL INV       64 S 16   9
ALTSHULER C-------*64*IEEE T ANTENNAS PROPAP 8  526
      IIZUKA K      IEEE ANTENN     N 65 AP13  469
ALTSHULER EE------*61*IRE T ANTENNAS PROPAAP 9  324
      WU TT         IEEE ANTENN       65 AP13  369
ALTSHULER KZ------*57*EUGENICS QUARTERLY--   4
      HANHART L     ACT GENET M         65  14   13
    ----------62-EXPANDING GOALS GENE□    275
      RAINER JD     NY ST J MED     M 65   65 1651
```

Figure 3. Example of automatic computer correction of spelling error in citation of Altshuler's work.

In producing our early experimental citation index files we were not verifying the punched card field containing the cited publication title. We encountered a case where one keypuncher consistently made a transposition finger error which changed "dairy" to "diary". The weight of her cumulated mistakes actually overrode the correct version in some instances when our unification procedure was applied. This resulted in printouts containing citations to a nonexistent *Journal of "Diary" Science*. Needless

to say, this was partially instrumental in our changing to full verification. This was not a trivial decision insofar as it involves more than 3 million cards per year.

In the preparation of the IBM cards for the *Science Citation Index*, all keypunched data are verified by a second operator or reader. The IBM 557 interpreter with proof feature is used to interpret the cards and edit for erroneous multipunch characters and a preliminary field edit. After all the errors detected by the verifier have been corrected, an IBM 360 computer is used to edit and identify any further errors of the type which can be checked for by algorithm. This very elaborate computer procedure confirms card sequencing, field positioning, and acceptability of the types of data allowed in the various field positions.

ASCA, the Automatic Subject Citation Alert, is a personalized selective dissemination system designed to alert any subscriber rapidly to the appearance of published material relevant to his interests. ASCA utilizes an extremely complex system to ensure that errors or variations in literature presentation do not interfere with the proper servicing of an individual's specific profile of interest. This control complex extends all the way from preliminary examination of each journal issue through assured receipt of reports in the mail. We try, for instance, to ensure the ASCA subscriber against an error of omission (whether ISI's or the postal system's) by sending him a report *every* week whether or not any information was detected. Figure 4 illustrates a report that is sent when a negative search has resulted for a particular week. The error we are ensuring against here is that the customer may have missed a report which did, in fact, contain information. As long as he knows that he must receive a weekly report, he then knows that the failure to receive such a report means that it has gone astray somewhere. For the rare occasions when that does happen, we maintain a file copy of every ASCA report so that it can be retrieved promptly for the customer who files a claim for a missing report.

a s c a

AUTOMATIC SUBJECT CITATION ALERT

a service of the **INSTITUTE FOR SCIENTIFIC INFORMATION**

DR. CHARLES VOYTKO
CHEMOBIOLOGY INSTITUTE
DEPT. OF RESEARCH
NEW YORK, NY 32516

D6679 ACCOUNT NUMBER
49 UNITS USED
1 UNITS REMAINING

REPORT FOR 22 OCT 65

68,448 citations from current scientific literature and current patents were processed for *ASCA* this week

NO HITS THIS WEEK. USE BACK TO ADD NEW ITEMS TO YOUR PROFILE.
ACCT NO 11

Figure 4. ASCA weekly report sent to subscriber when no new information has been detected in search.

Like any other large library, we must be careful about the receipt of our journals in order to guarantee prompt and complete coverage. We not only receive several copies of each journal, each of which may be received from different sources, but also use a rather elaborate journal inventory control system. Among other things, this system checks for the arrival of journals. As shown in Figure 5, the system also alerts each ISI product manager to those journals which have arrived—which are to be covered by his product—but have not yet arrived in his department.

Another very important and vital aspect of CC, SCI, and ASCA processing of journals is page-by-page indexing in contrast to the selective indexing done by most other services. Since ISI supplies well-defined outputs based on complete coverage of all the journals we process, we and the users know specifically what data *should* be found in the publications. This knowledge greatly facilitates the detection of errors of omission.

The inventory of journal issues indexed appears in every issue of CC, IC, and SCI, giving the user precise information on exactly what is, and thereby what is not, covered.

JOURNAL TITLE	VOLUME	ISSUE	MONTH	YEAR	DIST	RECEIVED ISI	STILL REQUIRED BY CC	STILL REQUIRED BY SCI
ZH FIZ KHIM	39	12	DEC	1965	S I	01-06-66		
BULL SOC ITAL BIOL SPER	41	19	OCT 15	1965	PK	01-13-66		REQ.
DIS COLON RECTUM	9	1	JANFEB	1966	PK	02-14-66	P REQ.	
NEPHRON	2	4		1965	PK	02-12-66	P REQ.	
PHYSICA STATUS SOLIDI	13	1		1966	SK	02-02-66		REQ.
SOVIET PHYS-JETP ENGL TRANS	22	1	4AN	1966	SK	02-02-66		REQ.
INORG CHEM	5	1	JAN	1966	SKI	01-07-66		
DOKL AKAD NAUK SSSR	165	6		1965	CKI	01-10-66		REQ.
ZH ORG KHIM	1	12		1965	C I	01-10-66		
BULL CHEM SOC JAPAN	38	12	DEC	1965	CKI	01-11-66		
ACTA CHEM SCAND	19	8		1965	CKI	01-12-66		
J ORGANOMETALLIC CHEM	4	6	DEC	1965	SKI	01-12-66		
ARCH PHARM	298	12	DEC	1965	PKI	01-13-66		
ISRAEL J CHEM	3	4	DEC	1965	CKI	02-12-66	S&P REQ.	
SOVIET PHYS-USPEKHI ENGL TRAN	8	3	NOVDEC	1965	SK	02-14-66	S REQ.	
ANGEW CHEM	78	1	JAN	1966	C I	01-15-66		
J AM CHEM SOC	88	1	JAN 5	1966	CKI	01-15-66		
ANAL CHIM ACTA	34	1	JAN	1966	CKI	01-17-66		
BIOCHEM J	98	1	JAN	1966	PKI	01-17-66		
CHEM PHARM BULL TOKYO	13	12	DEC	1965	PKI	01-17-66		
J PHARM SOC JAPAN	85	12	DEC	1965	P I	01-17-66		
DOKL AKAD NAUK SSSR	166	1		1966	CKI	01-18-66		
J PHARM SCI	55	1	JAN	1966	PKI	01-18-66		

Figure 5. ISI journal inventory system showing arrival dates and departmental requirement alert.

SCI coverage is identical to a cumulation of the weekly ASCA coverage.

The total error control which we employ is, in practice, inseparable from the total system of production. We consider it an important guiding principle that humans and machines be coordinated in error-checking systems—the two used in complementary capacities.

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Effects of Errors in the Chemical Literature on the Compilation of Critically Evaluated Data*

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Received May 11, 1966

The types of errors encountered in the chemical literature while compiling critically evaluated data are discussed.

In any program for the collection and compilation of data to obtain a set of critically evaluated tables, the investigator is plagued by errors in the literature he must use. These errors often seem trivial to an outsider, but to the person who is trying to obtain the "best" values possible, they are extremely bothersome. Such errors make it difficult to assess the true worth of the experimental measurements, which are often of high reliability; they cast shadows on the results, and may, in severe cases, cause the measurements to be discarded.

In our program at the National Bureau of Standards on the preparation of the tables of Selected Values of Chemical Thermodynamic Properties, we have encountered our share of these errors. The errors we are concerned with here are not those in experimental measurements due to systematic or random factors, or even to the misinterpretation of the measurements; they are the small typographic and calculational errors and errors due to careless writing. It is probable that these cause us as much trouble as the problems from the uncertainties in the measurements themselves—and cast doubt on many excellent sets of experimental data.

Perhaps a few examples out of the many we have encountered will indicate the types of "errors" that occur.

Ideally, a paper should give all of the experimental details and results, and the auxiliary data used, so that an evaluation of the results may be made. Unfortunately, because of space limitations, this is not possible today. (Even 75 years ago, when articles would run to 40 or 50 pages, the details were still not always given.) Therefore, a selection of the more pertinent results must be made. During this selection, during the recalculation of results into final form, during the preparation of the manuscript and the transformation into the printed page, there are many chances for errors to occur: errors of omission, of transposition, of inconsistent values.

It may be as simple as using the wrong molecular weight to convert from the specific quantities actually measured to molar quantities; but if the value used or the basic specific quantities measured are not given, this error is hidden. As an example, a recent paper from a reputable laboratory on the low-temperature specific heat of a compound gives the mass of sample used, the corresponding number of moles, and the molecular weight. The experimental results have been converted to the molar

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