

# Using the Engineering Index in Reference Collaboration at a Multi-Campus University

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## Abstract

Two Oklahoma State University librarians collaborated in a reference transaction involving a literature review. A collaborative approach was agreed upon when the librarians realized that they were working with the same graduate student, who commuted from the main campus in Stillwater to Tulsa to meet with his advisor, conduct his research, and complete the coursework offered at that location. The student was not familiar with the organization of the literature in the form of patents, technical reports, and online databases. He began by working from the book literature to determine the introduction of metal matrix composites, as indicated in patents cited in these resources. The student felt that a search was necessary to confirm whether or not any research was reported in the literature over a fixed time frame. Library resources at each of the two campuses were used in a complementary manner. The librarians collaborated to determine keyword phrases and their controlled vocabulary counterparts. The search presented the predicament of keyword versus subject thesauri term searching and the respective impact in regards to comprehensive database searching. A study of the print index indicated its evolution over time, which continued after the introduction of the online format. A DialogClassic connection at the Tulsa campus library was used for a search of the Engineering Index because the Engineering Index Backfile (1884-1968) was not available in Stillwater or Tulsa.

## Introduction and Background

A land-grant institution, Oklahoma State University was founded in Stillwater in 1890, as Oklahoma Agricultural and Mechanical College. The Tulsa campus became part of the Oklahoma State University system in 1999. The College of Engineering, Architecture and Technology offers bachelor's, master's and doctoral degrees for a broad spectrum of engineering disciplines. Research activities are closely coordinated between the two locations. Each campus has an advanced technology research center. Recently the university has begun to hire faculty exclusively for the Tulsa campus for a newly initiated materials science and engineering program. The research emphasis in Tulsa is advanced materials. A number of faculty have teaching and/or research commitments in both Stillwater and Tulsa. Library resources in support of engineering include the major online bibliographic and publisher databases associated with engineering and science, with the exception of the Engineering Index Backfile 1884-1968. These online databases are licensed for campus wide and proxy authenticated off-campus access. Many of the online databases are available on both campuses, with some exceptions. For the sake of simplicity, "Compendex Backfile" and "Backfile" will serve as a common name for the proper form, Engineering Index Backfile, which covers the period 1884 to 1968 inclusively for the Engineering Village platform.<sup>1</sup>

A student conducting research on metal matrix composites approached librarians on the Stillwater and Tulsa campuses separately. The student began with the Engineering Librarian, in

Stillwater. The faculty advisor consulted the selector of engineering materials in Tulsa. The goal for the student and his faculty advisor was to determine what options were available for a detailed literature review for the period of the twentieth century. Stillwater and Tulsa both have Compendex with coverage from 1969 to present on the Engineering Village platform<sup>1</sup>, but neither has the Compendex Backfile 1884-1968. Stillwater has the print format at an offsite location. The Tulsa location has a Dialog account. The selector of engineering materials referred the question to the Public Services and Electronic Resources Librarian, who is also located on the Tulsa campus. She has a background in general reference including expertise in database searching via Web-based products, including Dialog. She contacted the Engineering Librarian to discuss the resources, the vocabulary, and the desire to contain cost on the Dialog search. When it was discovered that they were working with the same student/faculty advisor team, the librarians decided to collaborate, to make use of skills and resources that neither campus held exclusively. Between the two, these librarians discovered a strategy that employed controlled and uncontrolled vocabulary as a guide in how to proceed with the indexes. Using the Engineering Index in three formats 1) print), 2) the online format, Compendex and 3) DialogClassic as well as the Engineering Information Thesaurus<sup>2</sup> made it possible to determine the appropriate search terms. The student and faculty advisor, henceforth referred to as the research team, were able to make better use of their time with the librarians collaborating than they would have otherwise.

Prior to consulting the librarians, the student searched Compendex and was distressed over the results he obtained. Initially, he did not understand that the Compendex Backfile was not available. He provided a list of keyword phrases to the Tulsa librarian in order to obtain the older material that was needed for his research. The student needed the librarians' assistance in learning how to search for and identify relevant citations for his literature review. Moreover, the librarians discovered they were working with the same student/faculty research team during a telephone call placed by the librarian in Tulsa. A collaborative approach was agreed upon during that call.

### Examining the Literature of Metal Matrix Composites

The student identified a literature gap regarding the topic of metal matrix composites, as follows. He began by working from the book literature to determine the introduction of metal matrix composites, as indicated in patents<sup>3</sup> cited in the book literature<sup>4</sup>, beginning in 1924 in Germany and not appearing again in the literature to his knowledge until 1952. What he needed was a search of the literature that would confirm whether or not any research on the topic occurred between 1924 and 1952. A technical report<sup>5</sup> was found on the web, indicating a Swiss patent<sup>6</sup> in 1947. A dissertation<sup>7</sup> was also found, confirming the German patents. Because he was not sure what had been documented, the student asked the librarians to extend the literature review from 1900 to the present.

### Review of the Literature Regarding Reference Collaboration

Librarians collaborate in regards to nearly every aspect of the profession.<sup>8</sup> The literature is silent regarding the frequency of reference collaborations between librarians in general. The literature does speak to the technologies used, specifically telephone, email, and synchronous and

asynchronous forms of digital reference.<sup>9</sup> Instantaneous collaborations between librarians at separate library locations were not possible until the telephone was adopted for reference service.<sup>9</sup> The literature also indicates collaborations that exist for the purpose and duration of a single reference question and longstanding, collaborative reference services such those found in library consortia.<sup>9</sup>

Collaboration among librarians at multi-campus institutions including universities has not received much treatment in the library literature.<sup>10</sup> An article describing a virtual reference service at a multi-campus university indicated the use of an online course management system in place of face to face meetings and monthly telephone conference meetings for the staff.<sup>11</sup> The same article gave no specific indications of reference collaborations between librarians; however, meetings by their nature make fertile ground for collaborative activity, regardless of the communication technology employed. Reference collaborations involving the Engineering Index Backfile and Dialog were not found in the literature. However, it seems likely that such collaborations have occurred given the large number of multi-campus universities that offer advanced degrees in engineering.

### Methodology

The Tulsa campus librarian contacted the librarian in Stillwater initially because she knew that the print format of the Engineering Index was held there, and that a search of the print index would save the cost of a Dialog search. Also, the Tulsa campus librarian did not know if the search terms provided by the student were controlled vocabulary from a thesaurus or not. Neither did the librarian know if the student's search terms were related to narrower or broader terms as found in a subject classification hierarchy. If the keyword phrases were not controlled vocabulary terms, then a search of the print index might prove to be unproductive. If the keyword phrases were not controlled vocabulary terms and were to be searched independently of each other, the Dialog search would be quite costly to perform. A thesaurus is a listing of the controlled vocabulary used to index literature.

Prior to the World Wide Web, database searches were conducted with vendors such as Dialog that charged by the minute, the number of citations and format of the output. Almost all searches were conducted by a librarian, often with the patron present to provide immediate feedback on the success of the search. Searches were performed by librarians, who held the account information, and were responsible for monitoring the cost. Before going online, a significant amount of time was spent with the requestor explaining how the search process worked and developing a detailed, yet cost effective search strategy.<sup>12,13</sup> Anything involving Boolean operators would lend itself to Dialog searching. Relatively simple subject searches could be addressed with the print index.

The librarian from the Tulsa campus asked the selector of engineering materials, also at Tulsa, to assist in locating historical annotations regarding the Engineering Index. The purpose of this was to develop an understanding of how the index evolved over time. This might be instrumental to ensure that her searching strategy was all-inclusive especially if the subject phrases/words changed over time. A keyword search is broad in scope, pulling from several areas in the record, such as the title, author, abstract, and in some cases all fields in the record.

In principle, a subject search should be more precise than keyword, because it uses the subject terms (controlled vocabulary) assigned by indexers. In reality, however, the precision associated with subject searching is dependent upon the extent that a topic maps to a subject term or terms.<sup>12</sup> “In some cases existing subject terms may be too broad which can mean lower precision and in other cases they may be too narrow with relevant citations missed.”<sup>12</sup> A subject search is limited to the subject field, by definition. The Tulsa campus librarian did not limit the search to the subject field, instead she performed a keyword search of selective keyword phrases using the Engineering Index Backfile (File 988) in Dialog.<sup>14</sup> A keyword search is a search of the “basic index”, which is the default, in File 988. The basic index provides access to keywords either in the title, abstract, descriptor or identifier field. (Also, the title field does not include conference title.)<sup>14</sup>

There were a number of unknowns. The terminology used by engineers to describe the topic may have varied considerably. The controlled vocabulary was not consistent, in that the thesaurus structure changed considerably over time. The amount of relevant information available was unknown as well. Because this topic was an area of discovery for the student, inclusiveness was desired in the search.

A preliminary search proceeded as follows. The student and the Stillwater librarian each generated a list of selective keyword phrases. The Tulsa librarian inquired of the student if singular and plural forms were a good strategy to search. For the preliminary search, the terms were re-written, to retrieve singular and plurals and truncated forms, using truncation operators, and for the terms in adjacent order, adjacency operators. A preliminary search of the Engineering Index Backfile from 1900 to 1968 in Dialog on selective keyword phrases determined how much literature existed (the number of citations) and whether the keyword phrases were relevant to the topic. For the Stillwater librarian’s search terms, a cost savings was realized for the DialogClassic search, by limiting the output to the quantity of citations available (a scalar value), instead of printing the citations. The decision was made to print all of the citations that corresponded to the student’s search terms because so few results were found. At this point, the librarians failed to notice an error in the search commands, which reduced the number of citations found for the student’s search terms. Immediately following the preliminary search, the Stillwater librarian and the student met to discuss the search strategy and the results.

Next, the librarians met face to face at the Oklahoma State University Library, in Stillwater. The librarians used the Engineering Information Thesaurus<sup>2</sup> to identify the controlled and uncontrolled vocabulary terms corresponding to the selective keyword phrases. The librarians worked from the fourth edition, which is not the most recent edition of the thesaurus. Metallic matrix composites was identified as a controlled vocabulary term in the print format of the Engineering Index. By identifying the controlled terms and their respective date of introduction, it was expected that the precision and the likelihood of a comprehensive search would increase. Historical information on the Engineering Index itself was discussed as well. The output for the follow-up search took the form of citation and abstract, with the additional cost justified on the student’s study of the preliminary search results. The librarians found that the Engineering Index and its thesaurus evolved over time. The thesaurus structure varied. An example of a recent revision is a change from heading—subject heading arrangement to arrangement by what was previously a subheading.<sup>2</sup> Also, by studying the search results it became evident that the

evolution of the Engineering Index mirrored the prolific growth of the literature of science and engineering during the twentieth century.

The print index is arranged by subject. For a search of the print index, the first concern was to conduct a comprehensive search satisfactorily in a short time frame. A consideration was made, again for cost savings, to have the student search the print indexes for a thirty-five year window, for citations whose existence was determined from the preliminary search. The student did not perform a manual search of the index; instead, the Stillwater librarian performed this search over the date range 1924 to 1947 and provided a scanned image of the citations to the student. In the time prior to electronic databases, a thesaurus was especially important because searching was done by subject rather than keyword, using print indexes. This was a tedious process in comparison to electronic databases which allow keyword searching of the citation, abstract, and in some cases full text.

The Engineering Information Thesaurus reflects the controlled terms presently used and the previous terms as well. When searching the online database all one needs to know is the controlled terms presently used; however, if one is searching the print index, then one must follow the indexing tool governing the respective index by year. As of January 1993, the Engineering Information Thesaurus has served as the indexing tool for the Engineering Index and the Compendex database.<sup>2</sup> In terms of breadth and depth of coverage for all topics in engineering, the Engineering Index is recognized for its comprehensiveness. The online thesaurus, which is available from File 988<sup>14</sup>, was not used, because of the cost and the collaboration factor. The librarians used the print format of the thesaurus instead.

In addition to the Engineering Index, other indexes were consulted initially. The bulk of the effort however was spent on the Engineering Index. Inspec and SciFinder Scholar were searched, Inspec for its coverage of materials and SciFinder Scholar for its coverage of chemistry. Web of Science was also searched because of its coverage of the sciences in general.

This endeavor was constrained by a need to produce a reasonably comprehensive search strategy at an acceptable cost. By limiting the number of citations printed via the preliminary and follow-up search, costs were contained with DialogClassic. At \$3.61 per citation and abstract, the 136 records for metal matrix composites and sintered metals cost \$491. This expense was paid by the Oklahoma State University-Tulsa Library. The expense for search time for the preliminary and follow-up searches was less than \$40. Overall, more than \$1,000 could have been spent, easily. For example, the same output format for intermetallic compounds, for which there were 619 records, would cost \$2,235. Had the research team asked for those records, the librarians probably would have suggested combining intermetallic compounds with another term such as sintered metals, or powder metallurgy, to reduce the number of results.

## Results

Student's keyword terms			
Terms	Dialog syntax	Results: 1900-1960	Results: 1900-1969
metal matrix	metal()matrix	3	52
metal composites	metal()composites	3	36
reinforced metals	reinforced()metals	0	16
fiber reinforced metals	fiber?()reinforced()metals	0	0
fiber reinforced metallic materials	fiber()reinforced()metallic()materials	0	0
filament and metals	filament()metals	1	1
Dispersed particles and metals	dispersed()particles and metals	3	8
whiskers and metals	whiskers and metals	8	51

Stillwater librarian's keyword terms		
Terms	Dialog syntax	Results: 1900-1969
metal matrix composites	metal?()matrix()composite? ?	27
sintered metals	sintered()metal? ?	109
sintered aluminum products	sintered()aluminum()products	3
metal powders and sintering	metal()aluminum()products	141
powder metallurgy	powder()metallurgy	2961
intermetallic compounds	intermetallic()compounds	619
dispersion strengthened metals	dispersion()strengthened()metals	8
dispersion strengthened aluminum	dispersion()strengthened()aluminum	5
dispersion strengthening	dispersion()strengthening	47

## Discussion of Search Results and Methodology

While the method was sound, an error was found in the search commands in the session transcript from Dialog. Instead of the intended date range 1900-1969, the date range 1900-1960 was entered for the student's search terms, in the preliminary search. This resulted in very low numbers for each of the student's terms, as shown in the Results section. When the corrected date range was entered the numbers increased dramatically, which is expected, given that the amount of published research increased dramatically between 1961-1969. See the corrected values, Results section. The research team was given all of the citations from the student's terms, but not the low quantities, specifically. This was an unintended oversight. For the Stillwater librarian's search terms, the research team received quantities, with no citations. For

the follow-up search, the research team decided to obtain citations and abstracts for metal matrix composites and sintered metals, terms offered by the librarian at Stillwater. In addition to this, the research team elected to receive citations and abstracts for four citations which were a result of their search terms.

Had they known that the values for the two topics, metal matrix and metal composites were actually much higher, the research team might have asked for citations and abstracts for those as well; however, one cannot necessarily make that assumption. If their research was more focused, then the results received were probably adequate. The research team might have requested citations and abstracts for the search, whiskers and metals, which had 51 citations for the corrected value, instead of 8. The extent that these items might have contributed to the comprehensiveness of the literature review is uncertain.

Had the results from the student's terms been compared to the results from the terms generated by the Stillwater librarian, the error could have been detected when it occurred. For example, consider a Venn diagram in which the Boolean operator AND is represented graphically by the intersection of two sets. The corrected values for metal matrix, 52, and metal composites, 36, is a more logical fit for the 27 items found for metal matrix composites. This in contrast to metal matrix, 3 items, and metal composites, also 3 items, for the date range 1900-1960.

As far as the thesaurus and controlled vocabulary terms are concerned, consider the following from Appendix A, under the Rationale. The Engineering Information Thesaurus<sup>2</sup> indicates that the controlled term, metallic matrix composites, was introduced in 1993, and that the previous controlled term was metals and alloys—metallic matrix composites, which was used in a search of Compendex from 1969 to 1992.<sup>2</sup> The search from 1900 to 1968 needed to use the appropriate controlled term, metals and alloys—metallic matrix composites and its variants, in order to increase the likelihood of a comprehensive search. As indicated in Appendix A, under the Rationale, “metals and alloys” was omitted from the term, metals and alloys—metallic matrix composites and metal?()matrix()composite? ? was searched for the years 1900 – 1969 inclusively. A decision was made to omit “metals and alloys”, because a search with part of a large string will retrieve items indexed with the part as well as the whole. The point here is that the term metallic matrix composites, in either form, as a heading or as a subheading under metals and alloys, is a controlled vocabulary term. Its status as a controlled vocabulary term contributes to the comprehensiveness of the two sets of search results that cover the time period 1900 – 1992. For the set of search results which correspond to the time period 1900 – 1969, the earliest citation in the 27 items that constitute that set is 1965.

As far as the keyword phrase sintered metals is concerned, consider the following assessment. This term was found in the technical report<sup>5</sup> and the dissertation<sup>7</sup>. By providing that term and results set, the librarians provided the research team with a significant set of citations. Of the 109 citations, the earliest citation in the set is dated 1937. There were three German citations in 1938 and two in 1939. One of the citations from 1939 is a book review on the topic. Also there was one German citation in 1941, and in 1945 there was an English language translation of a journal article from 1943, from Germany. These citations fit the literature gap between 1924 and 1947, as identified in the technical report and dissertation, and some are of German origin. None of the German citations were authored by Schmid, the inventor previously cited.<sup>3</sup>

The Stillwater librarian searched the print indexes, retrieving citations from 1924-1945. The search terms were identified from the literature and discussions with the student.

How well was the literature gap addressed by the strategy employed? Did the strategy contribute to a comprehensive search? For the gap, defined as it was, from 1900-1969, the print index yielded citations from 1924-1945, the Dialog search on metal matrix composites yielded citations from 1965-1969, and the Dialog search on sintered metals yielded citations from 1937-1969. The citations range from 1924-1969, which is probably a close parallel to the development of the physical artifacts; thus, the date range provides evidence in favor of a comprehensive search. The large number of concepts considered, 17 search terms, contributes to the likelihood of a comprehensive search as well. The selection process for the search terms metal matrix composites, a controlled term, and sintered metals, an uncontrolled term, as explained in Appendix A, builds a favorable case regarding the comprehensiveness of the literature review. A qualification that might be added concerning the comprehensiveness of the search is based on the tools available. Had the entire range of years for Compendex and the Backfile been available on one platform such as Engineering Village, more citations may have been retrieved. Using Engineering Village for Compendex and DialogClassic for the Backfile will likely produce a different set of results than using Engineering Village for the two files combined. DialogClassic and Engineering Village each have a unique search syntax. Another qualification is the use of adjacency operators instead of Boolean AND, which would have given more results. Adjacency operators were chosen to reduce the number of irrelevant citations. This choice may have affected the comprehensiveness of the search.

The student indicated that he and his faculty advisor were satisfied with the citations received, which is another positive indicator. It's a common practice in librarianship to receive anecdotal responses regarding the effectiveness of services offered. Furthermore, it's generally understood that the comprehensiveness of a literature review is a subjective rather than objective observation. In the case of a student's literature review, the final decision regarding comprehensiveness is made by the respective faculty advisor, not a librarian. The advisor's extensive knowledge of the subject matter qualifies him or her as the final arbiter in this process.

### Conclusions

In this study, two librarians navigated a landscape involving a complex historical literature review, an index in multiple formats as well as constraints on time and cost. The end result, a reasonably comprehensive literature review, could not have been achieved within the existing constraints, had the collaboration not taken place. The search of the Engineering Index Backfile was conducted with DialogClassic, a service that charges by the minute, the number of citations and format of the output. This stands in stark contrast to the online database format which is based on an annual fee and provides campus wide and proxy authenticated off-campus access. The student learned about the formats of the index and the organization of the engineering literature. The effort involved in managing an endeavor such as this speaks to the continual need for librarians to develop flexible ways of providing services when resources are not available. These librarians found this collaboration to be time intensive; however, by collaborating they were able to make use of skills and resources that neither campus held exclusively.

Appendix A: The use of the Engineering Information Thesaurus<sup>2</sup> from which controlled and uncontrolled vocabulary were located.

### Metal Matrix Composites

From 1993 to the present: subject search (not keyword): *metallic matrix composites*

From 1969 to 1992: searching Compendex on the Engineering Village platform.

A more flexible strategy to retrieve all of the relevant citations is to search by heading—subheading as well as the alternative, below, and compare the results. The term *metallic matrix composites* was a subheading prior to January 1, 1993.

On a single line in Compendex:

Subject search: *metals and alloys—metallic matrix composites*. Retrieve citations records indexed by heading—subheading

Alternative search, with each of the following on a separate line in Compendex:

Subject: *metals and alloys* (heading)

Keyword: *metallic matrix composites*. Retrieve citations indexed by *metallic matrix composites* as a subheading attached to another heading unknown to the authors, as well as the case of *metallic matrix composites* as a keyword, appearing anywhere in the record, including the title, abstract and so on.

From 1924-1968:

Subject search: *metals and alloys—metallic matrix composites*, using the print index.

From 1924 to 1968, this would require a search of 35 volumes inclusively. Originally, the plan was to have the student search the print indices to save money. Instead, Dialog was searched in phases and costs were monitored. The Stillwater librarian searched the print index.

In the Dialog search, the term *metals and alloys—metallic matrix composites* is altered.

Note that *metals and alloys* is dropped and *metallic matrix composites* is retained.

Searching with part of a large string will retrieve the “part” and any records with the large string. Also, adjacency and plural operators are employed.

metal?()matrix()composite? ? and years 1900 – 1969

Rationale: the term, *metallic matrix composites*, is the current subject term according to the Thesaurus<sup>2</sup>. In the language of database searching, a subject term is also referred to as a controlled vocabulary term. For print index, the assumption is that the subject term *metals and alloys—metallic matrix composites* would point to all vocabulary variations. For the Dialog format, the assumptions are that for 1900 to 1968, even though it is a search of the literature that precedes the currently used controlled terms, that literature is indexed using current controlled terms, given that as an online database each of the records has been amended through the addition of the controlled term presently used. The Thesaurus<sup>2</sup> indicates that the controlled term, *metallic matrix composites*, was introduced in 1993, and that the previous controlled term was

*metals and alloys—metallic matrix composites*, which was used in a search of Compendex from 1969 to 1992.<sup>2</sup> The search from 1900-1968 needed to use the appropriate controlled term, *metals and alloys—metallic matrix composites* and its variants, in order to increase the likelihood of a comprehensive search. As indicated above, *metals and alloys* was omitted from the larger string of terms and *metal?()matrix()composite? ?* was searched, for the years 1900 – 1969 inclusively. The logic behind this being that items indexed with the larger string would be retrieved in the search.

This search is made comprehensive, it is assumed by these authors, because older records in the online and DialogClassic versions of the Engineering Index are amended with the addition of currently used controlled and uncontrolled terms. Also, because abstracts are searchable in the electronic format, the likelihood that a search will be comprehensive has increased dramatically. In this study, the date that *metals and alloys—metallic matrix composites* was introduced as a subject term was not determined.

#### Sintered Metals:

From 1900 to 1968

In Dialog the search syntax used was *sintered()metal? ?*

Rationale: *sintered metals* is not a controlled vocabulary term, according the Thesaurus.<sup>2</sup> The term *sintered metals* was used because it was found in the literature. It retrieved 109 hits in Dialog file 988. Its citations were requested by the research team. To what extent the search that retrieved 109 hits is comprehensive, it is not clear. It is known from the literature that metal matrix composites can be manufactured by sintering metals. It is likely that the sintering described in this context became common practice at some time in the early twentieth century.

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