ABSTRACT

Business librarians can benefit from a deeper understanding of science and engineering resources, especially when researching technological topics, products, or industries. The authors introduce a variety of technical publications and databases useful for business research. Categories of resources described include technical encyclopedias and handbooks, periodical indexes and full-text databases, patents, technical reports, product literature, preprint and open-access repositories, conference proceedings, and dissertations. A case study based on MP3 audio technology demonstrates the types of business information which can be uncovered through a careful search of technical sources.

KEYWORDS
Technology resources, patents, technical reports, reference works
Most business librarians would readily agree with the proposition that science and technology publications can be important tools for business research. But how often do librarians turn to such resources to answer a business reference question? Based on anecdotal evidence, the answer is probably, “Not often enough.” The universe of business-specific information resources is so extensive, varied, and complex, that diligent business librarians spend much of their careers learning to master their use. From that perspective, it is not surprising that the correspondingly large and complex world of scientific and technical literature remains largely unexplored and underutilized by business researchers.

Other reasons can also be suggested to explain why business librarians don’t turn readily to technical resources. One likely possibility is that few business librarians possess a scientific background, making the subject matter difficult to comprehend. Just as librarians with humanities backgrounds may be intimidated by business resources, many business librarians consider the unfamiliar terminologies, methodologies, and concepts of scientific literature too formidable to tackle. An equally likely reason is that certain types of scientific literature are simply unknown to business librarians because those materials have no direct counterparts in the business literature. A third possibility may be the principle of “out of sight, out of mind.” For example, if prompted, a business researcher would most certainly agree that patent literature could be a useful source for business intelligence, but the thought of using patents to answer a reference query might not occur to him or her unless they had some successful cases of doing so in the past.

Business librarians seeking reasonable solutions to this shortcoming can:

- simply remember the rich information content in scientific literature and the possibilities it offers;
- cultivate a personal network of science librarians and consult with them when the need arises;
- become better aware of some of the most potentially useful categories of technical literature.

A review of the published literature shows little material that explains how business searchers can productively use technical information resources. A few articles, written mostly for technology managers, focus on technical intelligence (W. B. Ashton & Stacey, 1995; Sophie, 1998; Trumbach, 2006). Two articles deal exclusively with the value of patents for business researchers (Newton, 1998; Wu & Calhoun, 1992). One interesting article (Feeney & Martin, 2003) describes the joint effort by a science and a business academic librarian to provide information literacy instruction on finding business information to engineering students involved in product design projects. However, there is a dearth of articles discussing the full-range of technical information resources of value to the business searcher.

There are some helpful book length treatments in the area of technical commercial intelligence, though the discussion of actual resources and search strategies is rather limited (McGonagle & Vella, 2002; Walde, 1984). *The New Competitor Intelligence* (Fuld, 1995) is one of the few sources to go beyond patents to discuss other forms of technical literature like conference papers, specialized databases, and environmental notification forms with many
industry-specific case studies. Also of particular note is *Keeping Abreast of Science and Technology: Technical Intelligence for Business* (W. Bradford Ashton & Klavans, 1997) though a good portion of this book deals with setting up a technical intelligence group.

The purpose of this article is to introduce some key types of scientific publications that are especially useful for researching companies, industries, products, emerging opportunities, and related business topics. Among the resources described are technical handbooks and encyclopedias, periodical indexes, patents, technical reports, product literature, conference proceedings, and regulatory materials. A few less-obvious categories are also recommended, including preprints, open access archives, and dissertations. The example of MP3 players and related technologies will be used as a case study to illustrate the business value of technical publications.

**General Encyclopedias**

Before delving into the specialized realm of technical encyclopedias, let’s take a moment to revisit a more general topic. Remember back in high school or middle school, when you first learned how to conduct research to write a term paper? One of the beginning steps in the process was to read an article on your topic in a general encyclopedia, such as *World Book*. That advice remains just as appropriate when conducting business research on an industry, a product, a process, or a market, especially if it is a topic you know little about. A well-written encyclopedia article, when available, will provide you with a good introductory understanding of the subject in question. It will also identify and explain key terminology important to that topic, which in turn will provide you with keywords to use when searching other resources.

What information can a general encyclopedia supply that would be helpful to the business research process? It depends on the topic, but a good encyclopedia article can provide background on the history of an industry, product developments, technological innovations, and uses or markets for the product. For manufacturing industries, a general encyclopedia can provide an introduction to the raw materials used in production and steps in the manufacturing process. Because encyclopedia articles are typically written by experts in the specific topics, they are also a good place to find links to additional resources. Many encyclopedia articles include a brief bibliography of key materials for additional reading.

The three major general encyclopedias in the United States—the *World Book Encyclopedia* (World Book, Inc.), the *Encyclopedia Americana* (G罗lier, Inc.), and the *Encyclopaedia Britannica* (Encyclopaedia Britannica, Inc.)—all have online counterparts. The electronic versions are especially useful for their ease of use, keyword searching capability, and quick links to related articles.

Another useful approach is to consult popular science encyclopedias, especially those geared toward explaining how things work or how they are manufactured. Such tools may not be as current as you might need, and they may not cover the type of technology you are looking for, but it is always worth taking the time to check. Many of these encyclopedias are designated as “juvenile literature” by the Library of Congress, but don’t let that dissuade you; whether
the title is found in the Children’s section or the Adult reference section, such popular treatments may be just what is called for, especially if you know very little about the topic.

The simplest way to find encyclopedias that take a popularizing approach is to browse the reference collection in the sections for LC Class T and TS or to check library catalogs under the following subject headings:

Technology—Popular works
Manufactures—Popular works
Manufacturing processes--Popular works
Inventions—Popular works
Science—Popular Works

Examples of popular science encyclopedias include the following titles:

- *How Products Are Made* (Detroit: Gale Research, 1994--) 7-volumes.

Several Web sites also provide excellent starter information of this type, including:

- What’s That Stuff <http://pubs.acs.org/cen/whatstuff/stuff.html>
- Popular Science (Magazine) Online <www.popsci.com/popsci/>

General encyclopedias and popular science encyclopedias do have some obvious limitations. Timeliness is a particular concern, especially when researching new or rapidly changing technologies. Print encyclopedias address this problem by publishing yearbooks. Major online encyclopedias, such as Britannica and Access Science go even further, incorporating a variety of updating mechanisms into the product. Nevertheless, a general encyclopedia is not the best source for current information on a technical topic.

The other significant limitation to general encyclopedias derives from their strength. Because they are intended as a starting point on a particular subject, they are seldom detailed enough to provide an in-depth look at the topic under investigation. One solution to this shortcoming is to consult more specialized technical encyclopedias.

**Technical Encyclopedias and Handbooks**

Technical handbooks, manuals, subject encyclopedias, and similar works geared toward a more advanced audience can also serve as useful tools for business researchers. Some resources of this type are written for specialists in their fields—chemists, engineers, and other scientists who work in industry—but others are intended for a more general technical
audience. Much of the data found in these sources may be difficult for non-scientists to comprehend, but the typical technical encyclopedia will contain a wealth of introductory information invaluable to business users. As with general encyclopedias, technical encyclopedias and handbooks can provide useful information about the history of a product or technology, raw materials used in production, and the manufacturing process or processes. They typically contain helpful illustrations, including photographs, diagrams, exploded drawings, and flow charts. A technical encyclopedia will go into much more detail than a general encyclopedia, and may also supply information about environmental and safety concerns related to the materials used in the production process.

Some titles in this category serve as “workbench” tools, designed to provide chemists or engineers with a quick fact or specification as needed. Library science textbooks attempt to delineate the distinctions among the terms encyclopedia, handbook, and manual, but in practice, publishers tend to use such terms very loosely. Users should remember that a “handbook” may contain introductory or review textual material, extensive data tables and equations, or extremely technical descriptions and drawings. Needless to say, business researchers should look for tools that go beyond the ready-reference function, offering explanatory text rather than mere data tables.

For the purposes of this article, we will refer to any such narrative works as technical encyclopedias. They can appear as single-volume reference books, large multi-volume compilations, or anywhere in between. Some are arranged in alphabetical fashion, but most take a topical or thematic approach.

Technical encyclopedias and handbooks increasingly appear in electronic format, as stand-alone products or bundled in electronic reference collections. Examples of such collections include the Knovel Library (Knovel Corporation), the extensive line of NetBase products such as EngNetBase (Taylor and Francis Group, LLC), and more general collections, such as the Gale Virtual Reference Library (Thomson Gale).

Hundreds of specific subject encyclopedias are available, ranging from the Technology of Biscuits, Crackers and Cookies to the Handbook of Ceramic Grinding and Polishing. A handful of well-known, broad-based titles useful for a wide array of business topics are described below.

1) McGraw-Hill Encyclopedia of Science and Technology (Online version: AccessScience)
   The 10th Edition of this classic source was published in 20 volumes in April 2007. It contains more than 7,000 well-written and authoritative articles on all branches of science and applied technology. The online version offers enhanced content, including research updates, news stories, biographies, and links to high-quality external web sites.

2) Kirk-Othmer Encyclopedia of Chemical Technology (Wiley)
3) Ullmann's Encyclopedia of Industrial Chemistry (Wiley)
   These two classic encyclopedias are both available online via Wiley's Major Reference Works Online. Though similar in nature, for any given topic, each source will provide certain perspectives and details not found in the other.
4) **ASM Online Handbooks** (ASM International)

This source provides detailed information on the properties, processes, performance, and manufacture of engineering materials, including metals, plastics, ceramics, and composites. The online version includes the complete text of the 21-volume *ASM Handbook* as well as several “desk edition” encyclopedias, including the *Engineered Materials Handbook* and the *Metals Handbook*.

**Periodical Indexes and Abstracts**

Every successful business researcher quickly learns that periodical literature, including scholarly journals, popular magazines, professional publications, trade journals, and newsletters, are among the most important and heavily-used categories of business publications. Periodical databases such as *ABI/INFORM*, *Business Source Premiere*, *Factiva*, and *PROMT* serve as key resources in the business librarian’s arsenal. It is important to remember that searching beyond the familiar realm of business periodicals can often yield surprising results.

Most reference librarians are familiar with at least one of the major “supermarket” databases for searching large collections of journals across subject areas. In the academic arena, major examples are the Gale Group’s *InfoTrac OneFile*, EBSCO’s *Academic Search Premier*, ProQuest’s *Research Library* (formerly *PA Research*), and Wilson’s *OmniFile*. These leading vendors often have similar products aimed at the public library market, such as EBSCO’s *MasterFile Premier*. Many of these products are available in a variety of subsets to better suit provide subscribers’ needs and budgets. For example, EBSCO offers the *General Science Collection*, which provides full-text access to more than 60 of the most popular general-interest science magazines, with coverage back to 1992.

Aside from the huge array of full-text articles provided by these “omni” or “supermarket” databases, one of their key benefits is the ability to search easily across multiple disciplines. In this way, users will uncover information related to their topic which they otherwise may not have encountered. Because such tools include strong coverage of scientific and technical periodicals, they offer users a reasonably quick and painless way of casting a wider net. Researchers with access to Dialog’s global searching features or a Web-based federated search product can also conduct simultaneous searches across a wide array of subject-oriented periodical indexes and electronic journal collections.

Another useful approach is to go directly to the primary periodical index for the scientific discipline that is most closely related to the industry or business topic you are investigating. For example, a researcher looking for information on a new type of food additive will be amazed by what can be found in a chemical database, such as *Chemical Abstracts*. Specialized indexes covering the periodical literature of science and technology disciplines can be a powerful and effective tool for business research, in part because they incorporate periodical titles not found in the business indexes, but also because they provide a different indexing perspective or point of view.
Another important advantage of using technical indexes is that they typically utilize different indexing “hooks.” Because of its particular subject focus, a technical index will use specialized and detailed controlled vocabularies, additional keyword identifiers, and/or numeric codes not found in corresponding business sources. It is particularly interesting to note that scientific indexes often include coverage of relevant articles from business and trade journals. Because of the difference in indexing language and capabilities, users will sometimes find important articles that were missed when using business periodical indexes which covered the same titles. In addition, periodical databases in the sciences may offer special search features that provide capabilities unavailable in business resources. Examples include searching by the institutional affiliation of the article’s authors and searching for materials with certain physical or chemical properties.

A final benefit worth noting is that most databases in the sciences cover a variety of publication types beyond periodical articles. Examples of document types commonly found in technical periodical indexes include publication preprints, conference proceedings, books and book chapters, technical reports, standards, and patents.

A comprehensive listing of important periodical indexes is beyond the scope of this article, but the following titles provide a representative sample of some of the most useful and important for business research. Please note that updating frequency and span of coverage may vary depending on the vendor from which the product is acquired and whether additional backfiles are purchased. The dates below are for the oldest material available online and typically require purchase or subscription to separate backfiles.

**BIOSIS Previews**
Publisher: Thomson Scientific
Online Coverage: 1926+
Update Frequency: weekly
Journals indexed: 6,500

**BIOSIS Previews** is the world’s leading index for the entire field of life sciences. It incorporates information found in two print indexes: Biological Abstracts and Biological Abstracts/Reports, Reviews, and Meetings (BA/RRM). **BIOSIS Previews** focuses on the traditional areas of biology, including botany, zoology, and microbiology, but it also provides strong coverage of biotechnology, genetics, and other emerging fields. Interdisciplinary and related fields are also covered, including bioengineering, biophysics, biochemistry, environmental science, agriculture, and medicine. In addition to its exceptional handle on journal literature, **BIOSIS Previews** also indexes books, book chapters, conference proceedings and meeting abstracts, reviews, technical letters and notes, software, and selected reports. U.S. patents are indexed from 1986 through 1989 and from 1994 to the present. The database employs an extensive array of specialized indexing, including Biosystematic Codes (searchable by code name or number), hierarchical “concept codes” (e.g., “behavioral biology”), organism, chemical and biochemical names, Chemical Abstracts Service (CAS) Registry Numbers, gene names and gene sequence numbers, patent classes and patent numbers, and detailed indexing by “methods & equipment” and by “parts, structures, and systems, of organisms.” Business users will find additional useful indexes, such as document type, institution, meeting sponsor, and patent assignee.
Chemical Abstracts/CAplus/SciFinder Scholar
Publisher: Chemical Abstracts Service (CAS)
Online coverage: 1900+
Update Frequency: Daily
Journals Indexed: 9,500
Patents Indexed: 50 patent countries/organizations

Chemical Abstracts/CAplus covers over 27 million references to journals, patents, technical reports, books, conference papers, dissertations, electronic-only journals, and web preprints in chemistry, biochemistry, environment, chemical engineering, physics, materials science, and related areas. This database has long been known for its high quality, in-depth indexing and interdisciplinary nature, covering almost any material remotely related to chemical substances. Though the heart of the database is research-level material, it does cover some review and non-specialist articles useful for the general reader.

The SciFinder interface is especially powerful and easy to use. Results can be analyzed and refined by many fields, including organization, author, and journal name. SciFinder integrates MEDLINE, chemical suppliers, reactions, physical properties, and regulatory information along with the CAplus database. Abstracts are available only through various CAS-sponsored platforms including STN, STN Easy, SciFinder for commercial users, and SciFinder Scholar for academic users (www.cas.org). CA Search, a version of the database that contains citations and indexing without abstracts is available from a few vendors such as Dialog and Questel.

Compendex
Publisher: Engineering Information Inc.
Online Coverage: varies by vendor; backfile to 1884.
Update Frequency: weekly or monthly
Journals indexed: 2,600 titles

Known in print as the Engineering Index, this leading tool provides abstracts for several thousand journals worldwide, covering the gamut of engineering fields including aeronautical, chemical, civil, electrical, industrial, mechanical, petroleum, automotive, and metallurgical engineering. Compendex also covers related fields in technology and management, such as bioengineering, food technology, naval architecture, materials science, robotics, and environmental technology. In addition to comprehensive indexing of the relevant journal literature, Compendex provides selective indexing of government research reports, monograph chapters, and other non-periodical materials. The indexing structure uses subject headings and keyword identifiers, as well as a unique hierarchical numeric classification. For example, articles about computers are classified under code 72; articles on computer hardware are designated 722; and articles about computer peripheral equipment are assigned the code 722.2. Compendex also employs an article treatment field (in some systems called an “article designator” field) which includes such useful categories as “market survey,” “cost data,” “application,” and “management aspects.” Users can also search by publication type, conference name, and institution.

EMBASE
Publisher: Elsevier Science
This is the online version of the formidable *Excerpta Medica* indexing service. *EMBASE* focuses on medical information, with extremely strong coverage of pharmacological and other drug-related topics. *EMBASE* provides comprehensive coverage of drug research, pharmacology, pharmaceutics, pharmacy and toxicology, medical devices, clinical medicine, public health, occupational and environmental health, physical therapy and rehabilitation, health policy and management, basic biological research relevant to human medicine, alternative medicine; and more. It indexes publications from more than 70 countries. *EMBASE* is available online directly from Elsevier, and via several third-party vendors, such as Ovid. One of the best features of EMBASE is the capability for sophisticated drug-related research, including searching by drug name, CAS Registry Number, brand name, and manufacturer. Searchers can limit results within a specific EMTREE category; EMTREE is *EMBASE*’s proprietary subject thesaurus, arranged in hierarchical fashion from very broad to very specific biomedical concepts. *EMBASE* is also available to subscribers as subject-specific subsets, including the Drug & Pharmacology subset.

**Ergonomics Abstracts**

Publisher: Taylor & Francis Group  
Online Coverage: 1986+  
Update Frequency: quarterly  
Journals indexed: 300  

This specialized database results from a partnership between the Ergonomics Information Analysis Centre at the University of Birmingham and publisher Taylor & Francis. It covers the field of ergonomics, including human factor design and engineering. Related disciplines include psychology, physiology, biomechanics, job design, human-computer interaction, safety science, human engineering, medicine, occupational health, sports, and transportation. The database provides especially strong coverage of human-computer interactions and work-related physical disorders. Coverage includes journal literature and conference proceedings. The database does not employ detailed subject headings, but is searchable by a proprietary classification system (by code number or broad classification term). Users can also search by “application,” such as music, television, etc.

**IEEE Xplore**

Publisher: Institute for Electrical and Electronics Engineers (IEEE)  
Online Coverage: 1988, with selected titles dating back to 1913.  
Update Frequency: weekly  
Journals indexed: 151  

*Xplore* provides comprehensive coverage of publications of the IEEE and its British counterpart, the Institution of Engineering and Technology (IET) which was recently formed by the merger of the Institution of Electrical Engineers (IEE) and the Institution of Incorporated Engineers (IIE). Subject coverage focuses on electrical engineering, computer science, and electronics. The database contains more than 1.4 million full-text documents. Content coverage varies by subscription plan, but includes full-text articles, abstracts, and tables of contents of IEEE and IET journals, transactions, and magazines, full text of more
than 600 conference proceedings, and approximately 1,600 IEEE standards. Indexing utilizes the subject descriptors and identifiers found in *Inspec*, as well as authors, titles, and institutional affiliation. Users can also browse by publication name or conference proceeding. A real advantage of *IEEE Xplore* is in the ability to search for keywords in the full text of documents and to retrieve and view those documents.

*Inspec (Information Services for Physics, Electronics, and Computing)*  
Publisher: Institute of Electrical Engineers  
Online Coverage: 1898+  
Update Frequency: monthly  
Journals indexed: approximately 3,500  

This powerful resource is a combination of three print indexes: *Computer and Control Abstracts*, *Electrical and Electronics Abstracts*, and *Physics Abstracts*. It covers not only the areas suggested by the print index titles, but also control engineering, information technology, and communications. *Inspec* indexes a wide variety of document types, including trade journals, and is especially strong in its coverage of several thousand conference proceedings. In addition to a robust list of subject headings, *Inspec* entries include extensive use of keyword identifiers, a chemical name field, numerical property data, and a unique classification code structure. A handy capability within *Inspec* is the ability to search by article treatment, including “practical,” “economic,” “new development,” and “general or review.”

**MEDLINE/PubMed**  
Publisher: U.S. National Library of Medicine  
Online coverage: 1950+  
Update Frequency: Weekly  
Journals Indexed: 4,780  

*MEDLINE* is the premier database covering the fields of medicine, nursing, dentistry, veterinary medicine, and the pre-clinical sciences. Health care administration and related management topics are also well-represented in the database. *MEDLINE* includes all but approximately 1% of the citations in *PubMed*, NLM’s freely available web database. Abstracts are included for records from 1975 forward. Both *MEDLINE* and *PubMed* use highly detailed, hierarchical Medical Subject Headings (MeSH). Of particular interest to business searchers are three standard subheadings: “Economics”; “Statistics & Numerical Data”; and “Supply & Distribution”. For example, these subheadings are used under medical device subject headings like “Pacemaker, Artificial.” Searches can be limited by publication type, including “review literature” and “reference books.” *MEDLINE* is available by subscription from many vendors, including Ovid, EBSCO, ISI, and others. These vendors provide value-added features such as cross-file searching, complex search query options, and highly precise subject heading searching. However, the free *PubMed* version is generally simpler to use and more than adequate for many purposes. Natural language queries can be performed in *PubMed*.

*Wilson Applied Science and Technology Index/Index Retrospective*  
Publisher: H.W. Wilson Company  
Online Coverage: 1913+
One of the oldest indexes of applied science literature, the predecessor *Industrial Arts Index* began in 1913. The title split in 1958 to become *Business Periodicals Index* and *Applied Science and Technology Index*. The electronic version contains records beginning with 1983, and Wilson began adding abstracts in March of 1993. A separate product, *Applied Science and Technology Index Retrospective*, covers 1913 through 1982. ASTI indexes more than 400 core titles in a broad range of technical disciplines, from marine technology to textile science. Coverage ranges from scholarly publications to trade journals. Examples of journal titles include *New Scientist*, *EDN*, and *Machine Design*. The product is also available in a full-text version beginning in 1997. Like other Wilson indexes, title coverage is determined by a committee of librarians who solicit feedback from the library community via questionnaires. The index is especially recommended for its well-written abstracts. Another ASTI strong suit is its excellent indexing, with an up-to-date thesaurus of subject heading based on Library of Congress Subject Headings, as well as authority control for corporate and personal names. Special issues and features are also indexed, including conference issues, directories and buyer’s guides, and statistical supplements. The Document Type field is especially useful for searching, including such categories as Biography, Corporate Profile, Interview, Product Evaluation, and Reviews.

**Patents**

Perhaps no single category of technical information can provide more business and competitive information than patents. Companies use the patent system to protect their intellectual property in countries throughout the world, usually for a maximum of twenty years. It is this government-sanctioned protection that encourages companies to file patents, thereby publicly revealing details of their technology. Making this information public benefits countries since other researchers can build on this knowledge. However, there are many unintended benefits for the savvy business searcher.

An in-depth description of patents is beyond the scope of this article though there are many good book-length introductions to patents (Bouchoux, 2001; Bryant, 1999; Jester, 2004). The U.S. Patent and Trademark Office (USPTO) provides a brief primer at <http://www.uspto.gov/web/offices/com/iip/patents.htm#Patent>. A fine glossary of the many special terms used in the patent field is available at http://www.delphion.com/help/glossary.

The most obvious benefit to the business researcher is the ability to track an individual company’s research efforts, and, by extension, future commercialization plans. However, there are four other areas where analysis of patents can benefit the business searcher:

1) Overall technology trends can be tracked through the number of patents in given patent classes over time.

2) An analysis of which countries a company is filing in can indicate international marketing priorities.

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3) The background section of the patent places the particular invention in the context of the overall state of the art. Since prior art must be cited, often this section provides, in essence, a mini-review of the technology describing products, companies, key advances, and even market statistics.

4) Searching the full-text of patents by unique terms such as a trademark can indicate ways in which companies are using a product and may identify current and potential customers and new market segments.

An individual patent reveals little information about a company or technology area, especially since only a small percentage of patents actually result in a commercial product. However, using the power of public and subscription electronic patent databases, groups of patents can be quickly analyzed to reveal which companies are investing resources in studying what areas of technology. Such analysis typically involves a combination of company names (known as the assignee, i.e. owner of the patent), technology areas usually defined by a set of patent classes, and citation patterns.

There are drawbacks in mining business information from patents. A key drawback is the built-in time lag between the original filing of a patent and the publication of that application. In most countries, including the United States, that time lag is eighteen months.

In any patent analysis broken out by company, care must also be taken to establish the current owner of the patents of interest. Patents, since they provide an exclusive right for the owner to practice a particular technology or make a given product, are a form of intellectual property. Hence, patents are commonly licensed for use by or sold to other companies in marketing, merger, or acquisition deals. Large groups of patents are often shifted from an original owner (the assignee) to other companies when product lines or subsidiaries are sold off.

Ownership is complicated by the usual corporate name history of mergers, acquisitions, and subsidiaries. Determining who now owns or licenses and can legally use a particular technology can be a challenging task. Reassignments are recorded by patent office filings. Reassignment of U.S. patents since August 1980 can be searched via the free database provided by the U.S. Patent & Trademark office (USPTO) at <http://assignments.uspto.gov/assignments/?db=pat>. Similar information can be found at many international patent offices and in subscription databases like the IFI Current Patent Legal Status Database available on STN International or Dialog. Licensing information, if available, often must be ferreted out of the standard business news sources.

**Searching Patents**

Effective searching can be done on publicly available databases from the U.S. Patent & Trademark Office <http://www.uspto.gov/patft/index.html> and the European Patent Office <http://ep.espacenet.com/>, an excellent worldwide patent database covering over 70 countries including the United States, Japan, and all of Europe. A wide variety of fields can be searched including inventor, assignee, patent number, patent class, and keywords.
Keyword searching must be done with particular caution. Patents tend to use generic or highly technical language. For example, carbonless copy paper is often described as pressure-sensitive recording sheets. The amount of information such as abstracts or full-text that is searchable and displayable varies greatly by time period and country. For example, USPTO offers full-text searching back to 1976, but only patent number, issue date, and current U.S. class searching from 1790 to 1975.

Serious patent searchers usually prefer patent class searching to keyword searching. There are three major classification systems: U.S., International (IPC), and European (ECLA), each highly detailed with an extensive hierarchy. Class searching is made easier by online classification guides and hyperlink searching of class numbers in web databases. See, for example, the Index to U.S. Patent classes [http://www.uspto.gov/go/classification/uspcindex/indextouspc.htm](http://www.uspto.gov/go/classification/uspcindex/indextouspc.htm) and International Patent Class manual [http://www.wipo.int/classifications/fulltext/new_ipc/index.htm](http://www.wipo.int/classifications/fulltext/new_ipc/index.htm). One important caution is that all the patents of interest are seldom under a single continuous range of patent classes. For novice searchers, it is often useful to do a keyword or inventor search and examine the classes assigned to key patents.

There are many fine commercial patent databases. Though the base information is typically derived from national patent offices, various value-added features such as enhanced titles, data standardization and analysis, visual data mapping, and detailed indexing and classification codes are available in the commercial databases. Some of the major players in this field appear in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Major Patent Database Vendors</th>
<th>URL</th>
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<tbody>
<tr>
<td>Delphion (Thomson)</td>
<td><a href="http://www.delphion.com/">http://www.delphion.com/</a></td>
</tr>
</tbody>
</table>

Citation analysis is commonly associated with journal articles. However, patents cite both other patents and the journal literature. These citations can be analyzed to establish interrelationships between companies and technologies. The USPTO patent search system and a free utility, Citation Bridge ([http://www.patentcitations.com/](http://www.patentcitations.com/)), offer both cited (backwards in time) and citing (forward in time) reference searching.

**Patent Statistics and Analytical Tools**

Patent analysis as a competitive intelligence tool is one area that has received a fair amount of attention in the published literature. Unfortunately, many of these articles are published in journals targeting technology managers or librarians such as *World Patent Information*,...
Research Technology Management, and Journal of the American Society for Information Science and Technology which few business librarians would regularly track (Anthony, 2005; Dou, 2004; Narin, Smith, & Albert, 1993). Two articles focus on using patent analysis in merger and acquisition work (Anthony & Patrick, 2002; Anthony, Patrick, & Margaret, 2002). Use of sophisticated software packages and statistical techniques are well beyond the scope of this article. However, the business searcher can turn to some easy-to-use tools discussed below and in the case study at the end of this article.

The USPTO offers both standard statistical reports and custom data sets at [http://www.uspto.gov/web/offices/ac/ido/oeip/taf/](http://www.uspto.gov/web/offices/ac/ido/oeip/taf/). Standard reports include U.S. patent statistics by geographic origin, organization, technology area (patent class), inventor, and patenting trends. Particularly useful are patent classes, which are numerical subject classification codes assigned to all U.S. patents. A user-friendly, alphabetical index to these patent classes is available at: [http://www.uspto.gov/go/classification/uspcindex/indextospc.htm](http://www.uspto.gov/go/classification/uspcindex/indextospc.htm).

Below is a sample report (Table 2) that took only a few minutes to produce from the USPTO website that ranks the number of patents by company for the Patent Class 725 which covers interactive video distribution technology.

<table>
<thead>
<tr>
<th>First-Named Assignee</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>Total</th>
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<tbody>
<tr>
<td>Sony Corporation</td>
<td>11</td>
<td>20</td>
<td>16</td>
<td>10</td>
<td>14</td>
<td>71</td>
</tr>
<tr>
<td>Individually Owned Patents</td>
<td>11</td>
<td>19</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>64</td>
</tr>
<tr>
<td>United Video Properties</td>
<td>4</td>
<td>8</td>
<td>5</td>
<td>10</td>
<td>12</td>
<td>39</td>
</tr>
<tr>
<td>Matsushita Electric Industrial Co.</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>31</td>
</tr>
<tr>
<td>Scientific-Atlanta</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Intel Corp.</td>
<td>6</td>
<td>7</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Koninklijke Philips Electronics N.V.</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>7</td>
<td>12</td>
<td>23</td>
</tr>
<tr>
<td>General Instrument Corp.</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>International Business Machines Corp.</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Samsung Electronics Co.</td>
<td>8</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>21</td>
</tr>
</tbody>
</table>

The value of patent analysis in market analysis and forecasting is shown by the number of firms offering extensive software tools including sophisticated visualization/mapping tools and custom analysis of patent portfolios. Such firms include Manning and Napier (Rochester, NY [http://www.mnis.com/](http://www.mnis.com/)), ipIQ (formerly CHI Research, Chicago, IL).
Further examples of mining patent information for business information are shown in the “Case Study” portion of this article.

Technical Reports

Most technical reports are written based on contract or grant work sponsored by a governmental entity or non-profit organization. Perhaps the most valuable business-related aspect to technical reports is the relationship they establish between corporate authors (performing organizations) and the specific contracts/grants provided by the sponsoring organizations. As might be expected, these reports are usually very technical and detailed which limits their usefulness as a business source. However, like patents, some technical reports contain background and introductory information that may assist the business researcher. In an acquisitions/merger analysis, the government contracts and grants of the target company are valuable pieces of business intelligence.

The central clearinghouse for U.S. federally sponsored reports is the National Technical Information Service (NTIS) <http://www.ntis.gov/search/>. The complete database of citations and abstracts is freely searchable from 1990 forward. Older NTIS reports dating back as far as 1899, depending on the vendor, can be searched on a number of commercial database platforms. Vendors include Engineering Village, Ovid, EBSCO, ProQuest, and NISC. Although NTIS charges a fee for the full-text of the reports, many individual agencies and national laboratories have electronic versions of their reports available for free on the Web. The Association of College and Research Libraries has an excellent guide to these web resources. <http://www.ala.org/ala/acrl/acrlpubs/crlnews/backissues2004/march04/graylit.htm>. A few of the major sites are listed in Table 3.

<table>
<thead>
<tr>
<th>Table 3: Technical Reports Web Sites</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>GrayLit Network (DTIC, EPA, NASA, EPA)</td>
<td><a href="http://graylit.osti.gov/">http://graylit.osti.gov/</a></td>
</tr>
<tr>
<td>DOE Information Bridge</td>
<td><a href="http://www.osti.gov/bridge/">http://www.osti.gov/bridge/</a></td>
</tr>
<tr>
<td>Virtual Technical Reports Center</td>
<td><a href="http://www.lib.umd.edu/ENGIN/TechReports/Virtual-TechReports.html">http://www.lib.umd.edu/ENGIN/TechReports/Virtual-TechReports.html</a></td>
</tr>
</tbody>
</table>

Not all reports submitted to NTIS are highly technical in nature. Occasionally, even issues related to consumer products are covered. The usefulness of the following Federal Trade Commission report to a company tracking the video game market is obvious:


Despite the limitations of technical reports as sources of business information, it is a quick and free process to check the sources cited above to identify individuals and companies with technical expertise and active government contract work in areas of interest to the business searcher.

Technical Product Literature

When checking out a company or product line, chances are one of the first places that a business searcher will visit is the company’s own web site. Often, a wealth of financial information, news releases, SEC filings, mission and value statements, and general overviews of their business areas can be found there. One area that should not be overlooked is the technical product literature that often provides detailed specifications, features, and use information.

Companies selling products face a basic dilemma. On the one hand, they do not wish to unnecesarily reveal details about their product line to competitors. On the other hand, companies do want potential and current customers to have plenty of information about their products to stimulate sales. In addition, release of some technical information may be required by government regulation.

Given the cost of producing, updating, and distributing printed product literature, most companies make significant portions of their product literature available via the Internet. A wide range of literature may be available, such as sales brochures, technical bulletins, material safety data sheets, technical data sheets, laboratory manuals, usage guides, and specifications. Summary charts may compare features and specifications of various models within their product line and, at times, their competitors’ lines. Of course, any information derived from a company web site should be evaluated against other sources to identify biases, such as only citing data favorable to their products or stretching performance claims. Still, any legitimate firm is not going to intentionally misrepresent readily verifiable technical data and product features, if for no other reason than to avoid offending customers, not to mention ethical and legal ramifications.

Though business searchers may think to investigate sales literature at a company web site, the additional information provided by the more technically-oriented product literature should not be overlooked. Technical product literature may reveal many details of value to the business searcher, as the following examples illustrate.

- Material Safety Data Sheets (MSDS) are required for essentially all chemical substances including most consumer products used in the United States. They typically list composition and perhaps, percentages of ingredients, though some information may be shielded by trade secret exemptions. Impurities down to 0.1% are often listed, which may give clues to the process used to prepare the substance. Those unfamiliar with MSDS may wish to look at a consumer product example, Proctor & Gamble’s Old Spice After Shave.
  <http://www.pg.com/content/pdf/01_about_pg/beauty_care/deodorants/old_spice/old_spice/Old_Spice_After_Shave.PDF>
• Examining the technical literature may show that a particular aspect or property of a product is emphasized, indicating that the aspect or property is an important factor in its market uses. For example, the DuPont Company has an extensive list of datasheets, case histories, and Underwriters Laboratories information on the electrical insulating properties of Nomex®. This indicates that electrical applications are an important market for Nomex. <http://www.dupont.com/nomex/electapps/index.html>

• Application or use guides can give valuable data that might even be used to estimate other key information. For example, published statistics may list the number of acres treated by a particular herbicide. Using recommended treatment levels per acre from a company guide would permit an estimate of the consumption the herbicide. See Du Pont’s Cinch® ATZ herbicide product profile as one randomly chosen example. <http://www2.dupont.com/Production_Agriculture/en_US/assets/downloads/pdfs/K-04201.pdf>

• Although the help of a technical expert may be required, technical specifications may indirectly reveal information about manufacturing components, suppliers, processes, and costs. For example, size, type, or model number of a piece of equipment’s power supply may allow someone knowledgeable in the field to estimate cost or source of that particular component.

To this point, everything discussed in this section deals with information from a company’s own web site. However, under certain circumstances, companies must report key product information to governmental agencies. In most cases, the data released to the public does not reveal company-specific information. However, there are situations where company-level or even manufacturing site-level data is released to the public.

One very notable case is the Toxics Release Inventory (TRI) <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?TRI>, an annual inventory of environmental releases of 630 toxic compounds from over 23,000 facilities classed in any of 29 different SIC codes. Mandated by environmental laws and regulations, the facility-level reports are available on the public Internet and specify how the material is used at the facility (raw material, product, by-product, etc.), maximum amount on-site, and an estimate of quantities in pounds released to the air, ground, water, and off-site waste disposal. Although intended to provide important environmental health and safety information, TRI can also reveal a large degree of information about the products and processes operated at the site. Given the relatively small number of chemicals covered, this can be a bit of a hit or miss approach, depending on how many chemicals listed in TRI are used at a given site.

Still, by consulting with an industrial chemist, one can possibly use TRI records to determine with a fair degree of accuracy every product, by-product, raw material, and catalyst or other process chemical imported to the site, used on-site, and made at that location. With knowledge of basic process chemistry such as conversion rates of chemical reactions, one can estimate the yearly production of specific products, based on waste discharges, maximum quantities on-site, and type of use. The abbreviated TRI record below for the solvent, carbon
disulfide, for a New York 3M manufacturing plant gives an indication of the business value of legally required reporting.

**Sample 2003 Tri Record**

CARBON DISULFIDE [Chemical]
3M Co - Tonawanda
305 Sawyer Ave
Tonawanda, (Erie County) NY 141507798

Standard Industrial Classification Code:
2821 (Plastics materials and resins)
Latitude: 42 degrees 58 minutes 32 seconds
Longitude: 78 degrees 55 minutes 9 seconds
Facility Dun & Bradstreet Number: 002127124

Manufacturing Uses: (1a) Produce (1e) As a byproduct
Processing Uses: (2a) As a reactant
Maximum Amount on Site: Mean - 500000 lbs

Environmental Release of Chemical:
Total Air Release: 434,000 lbs./rep yr. 2003
Total Water Release: 0 lbs./rep yr. 2003
Total Land Release: 0 lbs./rep yr. 2003
Total Environmental Release: 434,000 lbs./rep yr. 2003

Off-Site Waste Transfer: Publicly Owned Treatment Works:
Name: Town Of Tonawanda Waste Water Treatment Facility
Street Address: 779 Two Mile Creek Road
City: Tonawanda State: NY
ZIP Code: 14150 County: ERIE
Total POTW Transfer: 6,200 lbs./rep yr. 2003

Other examples of detailed product information that can be tied to a particular company can be found for many products requiring health and safety clearance from the government such as pesticides, medical devices, cosmetics, and pharmaceuticals. Many business searchers may already be well aware of the value of product information submitted to government agencies regulating an industry segment they regularly deal with. If they are not aware of this or are working in an area outside their normal interests, one should become familiar with the agencies overseeing that industry, the regulatory reporting requirements, and the availability of this information to the public.

Technical product literature requires some patience in sorting through the technical detail to find information of value to the business searcher. It may also require consulting with a person who has an appropriate technical background. However, this section shows that this
extra effort can be a rewarding experience; one that would be missed by focusing solely on financial data and corporate news at company web sites.

**Other Forms of Technical Literature**

Business searchers should also consider other forms of technical literature beyond the better-known books, journal articles, patents, and technical reports. Conference proceedings, preprints, open access repositories, master’s theses and doctoral dissertations can be mined for additional insights into technologies in the process of being, or already, commercialized. These forms of literature usually can be most effectively searched using key technical authors or organizations that have been identified from other sources. Like technical reports, the technical detail of these special categories can be daunting for a non-expert. They also are typically, but not always, narrow in scope, doing little to set the specific work within a broader context. The great advantage of these forms of “grey literature” is that they are often publicly available far in advance of more formal publication in peer-reviewed articles and books, assuming the author even bothers to pursue further publication.

If a truly comprehensive and current picture of an individual’s or company’s technical base is required, these additional forms of literature should not be ignored.

**Conference Proceedings**

Tens of thousands of conferences occur every year. Papers presented at the conference may only be handed out to attendees. However, many times papers are published in print, on CDROM, or available on the Internet, either for free or at a cost. Conferences can range from the highly technical to trade/industry oriented, or can be a mix of both. Conference proceedings often contain details of corporate and government research in the individual papers. However, beyond individual papers, session topics can reveal the internal structure of a broader field and identify the current “hot” areas of research. Some conference proceedings contain keynote addresses or session introductory/overview papers that can provide general information of value to a business searcher.

To locate proceedings, it is helpful to first identify major societies and other associations in the field of interest through standard print and online association directories. Probably the best known general directory is the *Encyclopedia of Associations* (Gale Research) available in print and as an online database. Though the full-text of many proceedings must be purchased, web searches using scholarly focused engines such as Google Scholar <http://scholar.google.com/> or Scirus <www.scirus.com> will often uncover the existence and the availability of papers from many conferences.

Searching OCLC’s *WorldCat* database or public online catalogs of major libraries is also useful since most libraries catalog proceedings they own. OCLC also maintains two other databases useful in this area: *PapersFirst* and *ProceedingsFirst* which index, respectively, papers and proceedings held by the British Library. One of the best known conference papers indexing service is Thomson’s *ISI Proceedings* covering over 4.1 million papers from over
60,000 conferences since 1990. Print indexes, often limited to individual disciplines and/or superseded by online databases, are too numerous to cite here.

Many scientific databases index conference papers, including BIOSIS Previews (Biology), Chemical Abstracts, Compendex (Engineering), and Inspec (physics, electrical & electronics engineering, and computer & information science). For the business information professional, the value of searching conference papers can be demonstrated by the following record from Inspec which reports results from a market research survey which was presented at a technical conference.


From the abstract: “… little research has examined the effect of e-commerce's Web presentation on retail customer shopping experiences. The survey was administered to 117 undergraduate and graduate students. Several most important and influential Web sites in China were selected to explore these students' reactions to Web retailer's presentation of "mp3" products and services and to identify Web-site characteristics that contribute to customer satisfaction…”

Researchers can find numerous free sites on the Internet that list both recent and forthcoming conferences, including:

- MInd: The Meetings Index <http://www.interdok.com/mind/index.cfm> by InterDok offers free information about future conferences, congresses, meetings and symposia.
- Directory of Published Proceedings <http://www.interdok.com/dopp/dopp_search.cfm> is a companion archival file to MInd: The Meetings Index that gives basic bibliographic data about published conference proceedings back to 1994 and an option to purchase the proceedings through InterDok. This directory recently was made freely available on the web and is helpful especially for organizations that cannot afford WorldCat access. A small number of records list individual authors and papers, though full-text is not available on-line.
- Conference alerts <http://www.conferencealerts.com/> lists upcoming conferences in all academic fields. Searchable by field or country.
- AllConferences.Com <http://www.allconferences.com/> a directory of conferences, conventions, and trade shows in wide range of fields: sciences, business, humanities and all academic research areas.
- Natureevents <http://www.nature.com/nature-events/index.html> free, fully searchable, multidisciplinary science events database covering conferences, meetings, courses, symposia, forums, and other programs.
Preprint archives and open access repositories

Preprints, as their name implies, are articles made available, usually on the Internet, by the author prior to formal publication in a journal or conference proceedings. Authors may also deposit preprints, accepted papers, or unpublished (in a formal sense) working documents in Internet document repositories. These repositories may be hosted by the author’s institution, a scientific society, or some other national or international body. Normally, such repositories are open access, i.e. available freely to all. Some repositories may have a mix of documents available internally to members of the organization while other documents are available to the public. Two searchable directories of open access repositories are:

- Registry of Open Access Repositories (ROAR) [<http://archives.eprints.org/>]
- Directory of Open Access Repositories (OpenDOAR) at [<http://www.opendoar.org/>]

The use of preprint archives and open access repositories by researchers varies from country to country and by subject discipline. For example, physicists deposit a vast majority of their work with the Cornell (formerly Los Alamos) arXiv e-Print archive [<http://arxiv.org/>]. Chemists seldom file preprints. It would be an insurmountable challenge if every preprint and repository server needed to be searched one at a time. Fortunately, many of these collections comply with the Open Archive Initiative (OAI) standard that permits harvesting of the metadata by search engines. Many of the citations retrieved by search engines such as Google Scholar have been captured by this method. A table of a few of the better known scholarly archive metasearch engines is provided in Table 4.

<table>
<thead>
<tr>
<th>Table 4: Search Engine</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google Scholar</td>
<td><a href="http://scholar.google.com/">http://scholar.google.com/</a></td>
</tr>
<tr>
<td>Scirus (Elsevier)</td>
<td><a href="http://www.scirus.com/srsapp/">http://www.scirus.com/srsapp/</a></td>
</tr>
<tr>
<td>OAIster (Univ. of Michigan)</td>
<td><a href="http://oaister.umdl.umich.edu/o/oaister/">http://oaister.umdl.umich.edu/o/oaister/</a></td>
</tr>
<tr>
<td>DOE/OSTI E-print Network</td>
<td><a href="http://www.osti.gov/eprints/">http://www.osti.gov/eprints/</a></td>
</tr>
</tbody>
</table>

Theses and Dissertations

Like patents, technical theses and dissertations can be far removed from the world of business. However, many readers are probably aware of the extensive and growing effort by universities to commercialize technologies developed by faculty at their institutions (Stein, 2004; Young & Young, 2005). A survey by the Association for University Technology Managers reported that product royalties totaled $1.1 billion in 2003 across their member institutions (Schnitzler, 2005).

Although faculty wrote their dissertations in years past, their research students are currently writing dissertations in areas that are possibly in the process of being commercialized. Despite the highly technical nature and narrow scope of theses and dissertations, there may be times when a business searcher discovers that a particular business venture is based on work done at a university. In those cases, it would be of value to review the recently produced dissertations and theses of that research group.
ProQuest Dissertations & Theses is the major abstracting and indexing source in this field and provides subscribers with full-text of most documents since 1997. The database can be searched by faculty advisor making it easy to draw together work done under a key faculty member. It should also be remembered that not just science students write theses and dissertations. So do business and social science students, including communications majors.

Even searches using popular terms like “video on demand” or “voice over internet” retrieve records like:

- *A study of video streaming delivery protocols for efficient video-on demand services* by Chung, Yeonjoon, Ph.D., University of Minnesota, 2004.
- *Modelling of methods for wireless network access* by Barry, Thomas Andrew Linden, M.Sc., Trent University (Canada), 1999.
- *Adoption of voice over Internet protocol by North American service operators* by Ali, Syed Amjad, M.Eng., Carleton University (Canada), 2005.

Just the titles of these theses and dissertations show the potential value of this type of literature to the business researcher.

**A Case Study**

The technology behind today’s portable MP3 players is less than 20 years old, but the popularity of these devices continues to soar. Library patrons conducting business research on this product will find a wealth of supporting materials in standard technology resources.

In this case, basic encyclopedias may not be the best resource, given the rapidly changing nature of the field. Britannica has a brief article on “Digital Sound Recording” and another, even briefer, on “Data Compression.” World Book is a bit better, carrying a very brief article on the “Digital Music Player,” and longer article on the “Recording Industry” which contains a brief mention of MP3 technology. Despite these disappointing results, the encyclopedia approach provides clues for later searching in other sources, by suggesting additional terminology, such as MPEG, digital audio, audio compression, and data compression. Other standard sources, including McGraw-Hill’s AccessScience database which focuses more on underlying science than consumer devices, offer limited results for our beginning search. Given the nature of the subject, Wikipedia might be a useful resource, which turns out to be the case. It contains a fairly good article on the “Digital Audio Player,” though it is light on technological aspects. Wikipedia also provides a brief article entitled “Audio File Format.”

Another free Web site, How Stuff Works, is surprisingly helpful, providing two informative and highly readable articles: one entitled “How MP3 Players Work” and the other on “How
MP3 Files Work.” In addition to an easy-to-understand explanation of the technology, *How Stuff Works* also offers an excellent chronology of the technology and its predecessors.

A variety of technical encyclopedias cover the MP3 landscape, but also briefly. Examples include *Gale’s Encyclopedia of Science* (3rd edition, 2004), which contains an article on “Digital Audio,” and the *Encyclopedia of Information Science and Technology* (Idea Group, 2005), which has a similar article. One of the best sources for this topic is the *Encyclopedia of New Media: An Essential Reference to Communication and Technology*. (Idea Group, 2003). This single-volume encyclopedia offers several relevant articles, including one specifically on MP3s, as well as others on digital music, data compression, and Napster.

Science and technology periodical databases offer an embarrassment of riches on the topic of MP3 players, from basic information to highly technical research. EBSCO’s *General Science Collection* provides an excellent starting point. This database, covering general-interest science publications, such as *Popular Science, The Futurist*, and *Technology Review*, provides a diversity of useful background articles on MP3 devices and software, including product evaluations and comparisons, new product announcements, and “how-to” articles.

Moving on to core high-level technical files, a simple ‘mp3’ keyword search done simultaneously on *Inspec* and *Compendex* using the Engineering Village platform and limiting to publication dates of 2003 and forward provided these counts in April 2007:

- 307 unique to *Compendex*
- 351 unique to *Inspec*
- 113 duplicates covered by both databases
- A total of 884 records, counting duplicates.

This is one more vivid reminder of the extensive information available in technical databases and of the importance of searching multiple sources, even those closely related to each other in scope. Of course, a quality search query will take full advantage of the rich indexing and classification schemes of both databases. Using the automatic analysis feature of the Engineering Village platform, one immediately sees the top index terms, classification codes, authors, author affiliations, source titles, and author’s country for any search set. Using the 884-record ‘mp3’ set above produced these entries shown in Table 5 as the top items:

<table>
<thead>
<tr>
<th>Table 5: Analyze</th>
<th>Compendex (with hit counts)</th>
<th>Inspec (with hit counts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top 5 Index Terms</td>
<td>Algorithms (75)</td>
<td>Audio Coding (125)</td>
</tr>
<tr>
<td></td>
<td>Multimedia Systems (70)</td>
<td>Watermarking (57)</td>
</tr>
<tr>
<td></td>
<td>Computer Music (51)</td>
<td>Data Compression (50)</td>
</tr>
<tr>
<td></td>
<td>Internet (51)</td>
<td>Music (36)</td>
</tr>
<tr>
<td></td>
<td>Digital Watermarking (44)</td>
<td>Internet (34)</td>
</tr>
<tr>
<td>Top 4 Classification Codes</td>
<td>Computer Applications (159)</td>
<td>Speech and audio coding (127)</td>
</tr>
<tr>
<td></td>
<td>Data Processing (151)</td>
<td>Data security (54)</td>
</tr>
<tr>
<td></td>
<td>Information &amp; Communication Theory (101)</td>
<td>Digital signal processing (45)</td>
</tr>
<tr>
<td></td>
<td>Digital Computers &amp; Systems</td>
<td>Microprocessors and</td>
</tr>
<tr>
<td>Top 5 Countries based on author affiliation.</td>
<td>(89)</td>
<td>microcomputers (44)</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------</td>
<td>---------------------</td>
</tr>
<tr>
<td>United States (60)</td>
<td>(9)</td>
<td>China (65)</td>
</tr>
<tr>
<td>China (47)</td>
<td></td>
<td>United States (64)</td>
</tr>
<tr>
<td>Korea, Republic Of (27)</td>
<td></td>
<td>Singapore (34)</td>
</tr>
<tr>
<td>Taiwan (24)</td>
<td></td>
<td>Korea, Republic Of (28)</td>
</tr>
<tr>
<td>Germany (19)</td>
<td></td>
<td>Taiwan (27)</td>
</tr>
</tbody>
</table>

Note that the Engineering Village platform also automatically lists top authors and top institutions by name for any search set. However, the set used for this quick and dirty example was too small and too generic to provide meaningful results for those two fields.

Still it is clear that technical databases that provide a results set analysis feature can reveal significant information for business intelligence. Top countries, authors, and institutions take a few minutes to determine. One must take care to account for differences in database coverage. For example, the top country analysis above would seem to indicate that Inspec, being European-based, appears to provide better Far East, particularly China coverage, than Compendex which is based in the United States.

The other obvious advantage demonstrated by the Table 5 above is that a searcher can quickly develop an extensive list, really a road map, of relevant and related technical/search terms, even with the simplest of starting points, a single popular term like ‘mp3’. Clearly a searcher should not rely solely on popular non-technical terms in searching technical databases. However, as shown above, using the power of the Analyze feature, one can use the popular term as a starting point.

The authors are aware of three science-oriented platforms that readily perform this type of analysis:

- Engineering Village (Compendex, Inspec, NTIS, Geobase, and more)
- Web of Knowledge (Web of Science, BIOSIS Previews, MEDLINE, CAB Abstracts, and more)
- SciFinder Scholar (Chemical Abstracts and MEDLINE)

Finally, although many of the items retrieved are indeed very specific and technical, remember that this large technical database also cover sources targeting non-specialists and non-technical readers. For example, an article from a 2006 issue of IEEE Potentials entitled “Effects of MP3 Encoding on the Sounds of Music” explores sound quality issues in MP3 technology.

For the purposes of this case study, any number of additional periodical indexes could be used. To illustrate the point further, let’s choose three very different databases.

ACM Portal, a full-text database of journal articles, conference proceedings, and related literature from the Association of Computing Machinery, offers a wealth of potential research material. For example, an August 2001 article from the journal Communications of the ACM,
provides an excellent primer entitled “The Internet is Changing the Music Industry.” This database also suggests ideas for new product development, such as digital index-building technology for “content-based music retrieval.”

*IEEE Xplore* is, if anything, even more bountiful. A simple keyword search for ‘mp3’ or ‘mpeg” produced over 8,900 results. A quick inspection of results pointed towards the controlled vocabulary term, ‘audio coding’ which produced about 1,400 hits. One record with an interesting application for MP3 players was “Heart Rate Monitor for Portable MP3 Player” Jaywoo Kim; [et. al.] *IEEE-EMBS 2005. 27th Annual International Conference of the Engineering in Medicine and Biology Society.*

To demonstrate the value of searching less obvious technical databases, consider *Ergonomics Abstracts*. The idea of using this specialized database would not come readily to mind for most business researchers investigating MP3 players, but a quick search yields interesting results. In this case, *Ergonomics Abstracts* is a fruitful source of new product and design ideas for the MP3 market, uncovering potentially valuable articles on such topics as “gesture-recognition technology,” using speech-recognition for data entry, and combining MP3 technology with global positioning systems, to name a few.

Patent literature is an especially useful source for intelligence on MP3 player technology. Useful marketing statistics and related business facts can be gleaned from the background section of patents. Here are a few sentences from U.S. Patent 6,590,303 (July 8, 2003) issued to Motorola disclosing a single-button MP3 player:

“There is a trend in the electronic accessories business to converge devices. For example, cellular telephones are converging with personal data assistants (PDAs), … MP3 players, and the like. When electronic devices converge, however, the device can become complicated to operate.”

“While there are many portable MP3 players on the market, including those manufactured by Sony, Philips, and Audiovox, an extensive search of over 70 MP3 players on the market reveals that the typical MP3 player has five buttons or more.”

“This large number of buttons makes it difficult to merge MP3 players with cellular telephones without increasing complexity and cost. There is thus a need for a simplified MP3 player.”

These few sentences reveal a surprising amount about Motorola’s view of market trends (converging electronic devices), their customer focus (how devices can be made simpler), and an interesting market statistic (the average MP3 player has at least 5 buttons) that probably would be difficult to find in traditional business sources and certainly would take significant effort to develop independently. Note that three presumably important manufacturers are named.

Just as this article was being finalized, Apple released its iPhone. Though the Motorola example above was chosen months ago, the pre-nascence of this example is remarkable as
two of most notable features of the iPhone are that it has just one button and that it converges a large number of devices into a single unit.

This same Motorola patent cites 21 other U.S. patents, 2 press releases, and 2 newspaper articles. One of the older patents cited is an interesting one by Xerox for one-button searching of long lists, U.S. 5,786,819. This Xerox patent is cited by 18 other newer patents in addition to the Motorola patent. This ability to move backwards and forwards through the network of citations can be a very fruitful exercise to reveal unexpected relationships between different companies’ research interests.

Focusing on flash memories commonly used in MP3 players, a search of flash memory patents in the commercial database, SciFinder Scholar, retrieves 1,639 patents worldwide since the year 2000. SciFinder Scholar permits a one-button ranked analysis of any result set by organization. Hence, in a few minutes the top 5 companies patenting flash memory devices can be identified as shown in Table 6.

<table>
<thead>
<tr>
<th>Table 6: Companies</th>
<th>Patents 2000+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hynix Semiconductor Inc, S Korea</td>
<td>219</td>
</tr>
<tr>
<td>Advanced Micro Devices Inc, USA</td>
<td>156</td>
</tr>
<tr>
<td>Taiwan Semiconductor Manufacturing Co Ltd, Taiwan</td>
<td>116</td>
</tr>
<tr>
<td>United Microelectronics/Semiconductor Corp, Taiwan</td>
<td>86</td>
</tr>
<tr>
<td>Macronix International Co Ltd, Taiwan</td>
<td>70</td>
</tr>
</tbody>
</table>

It is clear that South Korea and Taiwan are the current hotbeds of research and, presumably manufacturing for flash memories. Though this would need to be verified through further research, it would be a reasonable assumption that most of these same companies are the actual manufacturers of flash memories inside the assembled electronic device, regardless of the brand name on the box.

Conference papers contain a wealth of information on MP3 players. Again, a simple keyword search of the Inspec database retrieves many references such as this paper discussing a solution to the problem of illegal copying of MP3 files:


As one example of the rich information contained in technical literature at company web sites, Sony Corporation has a product advisory/comparison web site covering all of their 45 models in this category at <http://www.advizia.com/v41/Advisor.asp?User=sonywalkman-lc&Rnd=687>. Products can be screened by 5 capabilities such as minidisk MP3 Player, 12 features such as weight or multiple language display, and 6 price ranges. Each model has a fairly detailed spec sheet including such things as their display type, e.g. ‘1-Line EL (Organic Electroluminescence)’. Clearly, the site is designed to assist consumers in making purchase
decisions, but it can be something of a gold mine for the savvy business researcher, including how to position a competing product.

Finally, turning to ProQuest Dissertations & Theses, below are a few sample citations related to MP3 players from this database:


Conclusion

This article (and its accompanying case study) demonstrates the tremendous power that science publications and databases can bring to a business search, especially for research projects involving technological products or industries. Furthermore, it suggests that business librarians, competitive intelligence analysts, and other users need not be technology experts to benefit from consulting such resources. Although business researchers are likely aware of the existence of technical encyclopedias, journals, and technical databases, they may not think to use them when the need arises. Similarly, most business librarians have a nodding familiarity with patent literature, but few understand the detailed business information contained within. It is hoped that, by describing the specific capabilities of these tools, together with those of less readily known categories of technical publications, this article will encourage readers to explore the rich potential of non-business resources.

REFERENCES


