



Research skills are essential to your work as engineers. The work that engineers perform – including the primary research that engineers may carry out – is never completely novel; it is always based, in some way or another, on someone else's past work, even if it takes a completely different approach. This page provides an introduction to conducting and understanding secondary research in engineering.

Conducting Secondary Research: The first step is finding the relevant materials. You have two main options for locating potential sources: Internet Search Engines or Library Search Engines.

1) Google, or other Internet Search Engine: The phrase "Google is your friend" is only half true: Google, or any other internet search engine, can be a great resource for information on a certain topic, but depending on your search terms, the hits that it returns may not be the most relevant or useful. Google, for example, arranges its hits through a proprietary PageRank system, which factors in many different criteria into the ordering of the web pages. You may find yourself flipping through multiple pages of links before finding a really relevant study.

Secondly, researchers need to consider the authority, authenticity, impartiality and trustworthiness of the pages that Google pulls up. Researchers looking for information on "How Plasma Televisions Work" will be confronted by a multitude of sources, including pages from universities, companies, individuals, and places like HowStuffWorks.com. A page from Sony might be informative, but would it be unbiased in describing the benefits of its proprietary implementation of Plasma technology? A page from HowStuffWorks.com might be unbiased, but would it be appropriate for graduate students looking for information on a specific

implementation of the technology? A page from an individual with no official qualifications might provide a detailed review of the technology required by a graduate student, but could you trust its authority or authenticity (*could the individual have copied the information from elsewhere?*)? When using Internet search engines to find information, always question the source.

2) Library Search Engines: As a U of T student, you have access to one of the largest collections of electronic and print resources in North America. The starting point of your academic search should be the Library's website: <http://www.library.utoronto.ca>. The Engineering Library, located on the second floor of Sandford Fleming Building, also has excellent librarians who can help you in your search.

There are several types of searches that you can conduct, which will result in different types of sources:

First, the **University Catalogue** (http://webcat.library.utoronto.ca/index_others.html) is a listing of all of the books, magazines, and journals the libraries at U of T hold. The list is searchable through Author, Title, Subject, Keywords, etc.

The **Electronic Resources** (<http://www.library.utoronto.ca/resources/>) section of the Library contains all of the online resources that the library provides access to: this includes electronic versions of books, magazines, journal articles, and most importantly, electronic indexes.

Journal Articles are the most important type of resource for engineers. Journals are scholarly publications, published periodically (usually 1-4 times a year), containing information from experts

on current research in specific fields. An academic journal is usually “**peer reviewed**” or “**refereed**.” Unlike in magazines, articles in journals are not usually commissioned; nor does one editor decide what is accepted or rejected.

“**Peer review**” or “**refereed**” refers to the article submission process: in these types of journals, articles submitted for publication are sent to a number of reviewers who are also experts in the field. These reviewers are not given the names of the authors (so the process can be impartial – this is referred to as “blind review”), and decide whether or not the article is accepted for publication, rejected, or sent back for editorial changes before publication. This strict review process is intended to ensure impartiality and a high standard of work. **Ulrich’s Periodical Directory**: (<http://myaccess.library.utoronto.ca/login?url=http://www.ulrichsweb.com>) can tell you whether or not a journal is peer reviewed (*look for the Referee’s symbol next to the journal name*).

Electronic indexes

(<http://link.library.utoronto.ca/eir/EIRsearch.cfm?T=1>) provide searchable listings of journal articles by topic. They allow you to search for relevant articles in a number of journals using title, author, subject, and keywords. You can search for relevant electronic indexes by subject (*i.e. Engineering and Technology*). Each electronic index will come with a description of its scope and content, and you can find the list of journals that it covers.

Useful Electronic Indexes for Different Engineering Fields:

Computer and Electrical:

Compendex

INSPEC

IEEE Explore

Electronics and Communications Abstracts

Applied Science and Technology Abstracts.

Biomedical:

MEDLINE

Biotechnology and Bioengineering Abstracts

Bioengineering Abstracts

Chemical:

Compendex

Chemical Abstracts

American Chemical Society Publications

Civil:

CSA Civil Engineering Abstracts

Civil Engineering Database (CEDB)

Earthquake Engineering Abstracts

Compendex

Civil Engineering Theses

Mechanical:

CSA Mechanical and Transportation Engineering Abstracts

Compendex

Check under *Engineering and Technology*, and other subject areas for other engineering fields. In most cases, you will have access to the abstract, a summary of the article’s content, and can decide whether or not the article is relevant to your work there. In many cases, you will have access to the entire article online, in .pdf format. Some journals and older publications may not be accessible online; for these, you’ll have to search the periodical section of the library for the hard copies of the journals. Older journals issues are usually bound together into one hardcopy volume per year.

Important Note: in order to access these e-indexes and online journals from home, you will have to have your library card number and a PIN number.

Understanding Secondary Research in

Engineering [1]: Publications from journal articles are usually highly technical and aimed at a very technical audience (other experts in the field). This can make them intimidating to read and difficult to understand, especially for first and second year students. However, they generally follow a basic framework that is universal across engineering disciplines.

Bill Griswold’s excellent article “How to Read and Engineering Paper” outlines such a framework, breaking down the engineering article into five key components (*below, we’ve listed four*

of the components and combined Griswold's #2 and 4) and questions readers can ask of the articles.

1. **Motivation or Problem:** What is the motivation for the work, or what problem does it address? There are often two levels of problems, what Griswold calls the "people problem" – *for example, slow synchronization between computers and PDAs* – and the "technical problem" – *the method used for synchronizing information between PDAs and computers (reads and checks all records first, the overwrites every item)*.
2. **Solution or Approach:** What is the solution – hypothesis, idea, method, or actual device – that solves the problem? How does the solution address the limitations of previous methods or the technical problem? *For example, a method for synchronizing called Fast Sync, which only overwrites information that has been changed.* What is the paper's contribution to the field?
3. **Evaluation of Solution:** What are the claims that author makes about the technology? How well does it solve the problem? What are its limitations?
4. **Future Work or Research:** What future work or research comes out of this paper? How might the limitations of the solution be addressed, or how might the solution be improved? [1]

Using this framework, it is possible to extract key information from even the most technical of articles. In fact, it is likely that some aspect of these four main elements will appear in the abstract or the introduction to the paper. (*See Components of Documents /Abstracts and Executive Summaries and/or /Introductions for more on how to locate this information in these two components*). Focus on establishing this very general framework first, before trying to develop an understanding of the details of the solution or method.

[1] Griswold, B. "How to Read an Engineering Research Paper." 31 July 2005 <http://www-cse.ucsd.edu/users/wgg/CSE210/howtoread.html>

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